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Supply Chain Resilience in Small and Medium-Sized Danish Manufacturing Enterprises

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October 2024

This report contains the practical dissemination of the project reported in the academic article: Stentoft, J., Mikkel, O. S. & Kjær, T. H. (2024), “Towards supply chain resilience: A structured process approach”, Operations Management Research (early site).

Supply Chain Resilience in Small and Medium-Sized Danish Manufacturing Enterprises

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The project has been carried out with financial support from the Danish Industry Foundation and the final material is delivered in Danish. We have received several requests about access to the material in English. These requests have now been fulfilled with an English version developed with assistance from ChatGPT.

The project's website is:
www.scr-smv.dk

The research project has been conducted by researchers from the Department of Entrepreneurship and Relationship Management, University of Southern Denmark, Kolding, in collaboration with employees from 18 participating companies.

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Summary

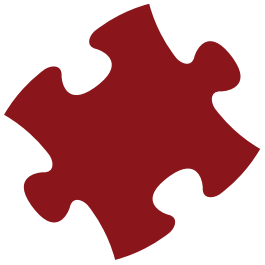
This report is the result of a two-year project at the Department of Entrepreneurship and Relationship Management, University of Southern Denmark. The project has been carried out with financial support from the Danish Industry Foundation. The project focuses on strengthening the resilience of Danish manufacturing companies against disruptions in supply chains. Although the project specifically targets small and medium-sized enterprises (SMEs), the concrete results of the project can also be utilized by large companies. The project has delivered two novelties: 1) the development of a process model that emphasizes the importance of cross-functional participation in the process of enhancing resilience in supply chains, and 2) the creation of an intuitive digital tool that can be freely downloaded from the project's website, and through short videos, one can quickly grasp the entire process.

In total, 18 companies participated in the project through two phases: 1) a development phase and 2) a testing phase. Ten companies were initially ready to participate in the development phase, but two companies had to withdraw their participation due to a significant workload caused by COVID-19. In the development phase, the eight companies were individually visited three times over three days, with a fourth day dedicated to a common evaluation session. On the first day, interviews were conducted with a team consisting of representatives from various functional areas (sales, production, procurement, finance/IT, and product development). The purpose was to gain a deeper under/standing of the companies and their challenges, including those resulting from COVID-19. The second day began with presenting the results of the interviews from the first day to the team. Then each participant worked on identifying the vulnerabilities they considered most important for their company to address, as well as the capabilities necessary to manage those vulnerabilities. The participants used physical cardboard cards (red cards for vulnerabilities and green cards for capabilities) for this exercise. The project group collected and manually processed each participant's work.

On the third day, the results from the second day were presented, followed by a collaborative exercise where the team worked together on the same task as day two. Day four took place at the University of Southern Denmark in Kolding, where company representatives participated in a process focused on developing action plans and handling development in a busy everyday environment. They also shared valuable insights gained from the development phase. The participants contributed with concrete suggestions for tools that could be developed. A significant learning from the development phase was that working with predefined vulnerabilities and capabilities worked well. However, it became clear that a more efficient way of processing data was needed. Consequently, during the summer of 2022, a digital solution was developed to work with vulnerabilities and capabilities and to provide a quick overview of individual participants' responses. Additionally, the development phase allowed for the evaluation of the used vulnerabilities and capabilities, leading to a substantial revision to ensure their relevance for Danish manufacturing companies anno 2023.

In the second phase, the testing phase, 10 companies participated. The developed process model consists of four phases: 1) map the supply chain, 2) identify vulnerabilities and capabilities, 3) prioritize and create cross-organizational alignment, and 4) develop action plans. Based on the learnings from the development phase, the process underwent several changes in the testing phase. Firstly, it was found highly valuable to start the process with a joint mapping of the company's supply chain, including discussions within the team about the challenges experienced in the company's supply chains. Additionally, videos were recorded to explain the process model and how to work with the model during the phase. In phase 2 of the process model, the different functional managers in the company individually assess vulnerabilities and capabilities based on the results of the mapping in the first phase. The represented functions include sales, planning/logistics, production, procurement, finance/IT, and product development. Participants now work directly in the developed digital tool. In phase 3, the work from phase 2 is repeated, but now it is done collaboratively with the entire team. Here, the importance of the individual work within the functions on vulnerabilities and capabilities before the collaborative process becomes evident. This allows the quieter individuals to participate in the joint process by making all participants' responses visible to the entire team which has fostered constructive dialogues. Phase 4 involves developing concrete action plans for reducing vulnerabilities and strengthening capabilities.

The process model has demonstrated its strength in facilitating discussions across the functions of the company. In all companies, reflections on the process have centered around the importance of a joint cross-functional dialogue. The feedback from the companies is quite clear: This is something that happens far too rarely! It is recommended to go through the phases of the process model at regular intervals, for example, every six months. The business environment is highly dynamic, which may require revisiting the work on vulnerabilities, capabilities, and prioritized areas of focus. The process model, with its predefined vulnerabilities and capabilities, provides structure and a shared conceptual framework that the participants have found very useful.



Along with the process model, 32 tools have been developed, some of which are to be used directly in connection with the process, while others can serve as supplementary contributions to the process. The tools are available on the project's website: **www.scr-smv.dk**.

In addition to the process model and tools, a national questionnaire survey was also carried out where 246 manufacturing companies participated. The survey shows that the competitive situation is particularly influenced by rising inflation and energy prices. The results also reveal a shortage of qualified workforce, especially engineers, industrial technicians, skilled workers, sheet metal workers and blue color (production employees). The respondents find that they generally have a good understanding of the vulnerabilities of their companies, but a lesser understanding of the capabilities that need to be strengthened. When it comes to specific questions about Supply Chain Resilience measures, the results indicate room for improvement.

The survey also reveals that there is generally good knowledge about cybersecurity, but this knowledge is notably higher among large companies. Regarding preventive activities related to cybersecurity, there is clear potential for improvement among SMEs in terms of employee training in cybersecurity and collaboration with partners in the supply chains on cybersecurity. Regarding established guidelines for what to do during a cyber-attack, the data shows that large companies are well-equipped to isolate the incident, ensure real-time monitoring, and communicate with relevant partners in the supply chain. SMEs do achieve lower average scores here, particularly in terms of communication with partners in the supply chain. Similarly, when it comes to guidelines for what to do during/after a cyber-attack, the data indicates a need for efforts in collaboration with partners in the supply chains, although data backup and system restoration are well managed.

Overall, the data shows a significant lag in cybersecurity knowledge and ongoing preventive measures among SMEs. Respondents generally state that they are well-integrated within their companies, which is a good starting point for work on Supply Chain Resilience. However, respondents point out a lack of implementation capabilities for change projects in the supply chains, indicating a need for external assistance in creating more robust supply chains.

The survey also indicates a low level of digital transactions with partners in the supply chains. The use of software for internal processes is most common in invoicing and payment processes, processing purchase orders, and procurement management. There is clear potential for improvement in using software for demand management and supplier selection processes. Finally, the survey shows a generally low usage of external facilitators/consultants to drive and implement improvement projects.

The project's results have been disseminated to public and private consultants through Danish business houses and municipal business services.

Preface by the Danish Industry Foundation

The Danish Industry Foundation aims to generate new knowledge, enhance skills, and foster valuable innovation for Danish companies, thereby boosting the competitiveness of Danish businesses. This focus is particularly crucial in an increasingly volatile business environment. This report presents the findings of a two-year project funded by the foundation, which aimed to enhance the resilience of supply chains in small and medium-sized Danish manufacturing companies.

The project was initiated in direct response to the COVID-19 pandemic, which exposed the vulnerability of companies' supply chains. However, pandemics are just one example of the various disruptions that can impact supply chains, including geopolitical tensions, cyber-attacks, natural disasters such as earthquakes, volcanic eruptions, and hurricanes, as well as human-made problems like incidents such as the grounding in the Suez Canal. The project's results encompass all forms of disruptions.

The project has successfully developed a process model aimed at enhancing the resilience of small and medium-sized production companies in the face of supply chain disruptions. This achievement was made possible through the active participation of 18 companies, which played a vital role in the development and testing phases of the project. As a result, the process model has been designed to be highly practical and beneficial.

The process model places significant emphasis on cross-organizational participation, involving representatives from various departments such as sales, production, procurement, finance, IT, and product development, while also emphasizing the importance of top management support. The project highlights the pressing need to break down internal silos within small and medium-sized companies.

Moreover, it underscores the value of investing sufficient time in open discussions to address the challenges faced by companies and explore potential

solutions. Equally important is dedicating time for the concrete implementation of improvement initiatives.

The process model itself is intuitive and user-friendly, consisting of four distinct phases. These phases encompass mapping the supply chains, assessing vulnerabilities within the supply chains, identifying the necessary capabilities to address these vulnerabilities both individually and jointly across functions, and ultimately developing action plans. The project's website provides comprehensive documentation of the process model, accompanied by a digital tool and 32 related tools that can facilitate the implementation of the process. Additionally, there are instructional videos available to offer guidance on utilizing the process model effectively.

We hope that the results of this work will serve as a source of inspiration, motivating collective efforts to enhance the resilience of supply chains and ensure the sustained competitiveness of Danish manufacturing companies

Charlotte Kjeldsen Krarup
Development Director
The Danish Industry Foundation

Preface by the Authors

This final report presents the findings of a two-year research project titled "Supply Chain Resilience in Small and Medium-Sized Danish Manufacturing Companies" funded by the Danish Industry Foundation. The project was conducted by employees from the Department of Entrepreneurship and Relationship Management at the University of Southern Denmark, spanning from May 2021 to June 2023. The primary objective of the project was to identify and address supply chain vulnerabilities in Danish manufacturing SMEs, with the aim of significantly enhancing resilience within this particular business segment. The overarching goal was to strengthen and cultivate the resilience of the target group, enabling them to effectively navigate supply chain disruptions stemming from various factors, including pandemics, geopolitical tensions, climate changes, and inflation.

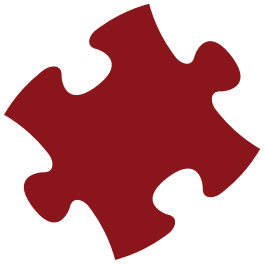
The Danish economy, being a small and open one, relies heavily on international collaboration and the seamless flow of goods both in terms of sales and supplies on a global scale. Consequently, most Danish SMEs operate with intricate supply chains encompassing significant complexities, extensive distances, and numerous intermediaries. As the COVID-19 crisis has already revealed, Danish supply chains are particularly susceptible to unforeseen events and diverse disruptions. Looking ahead, building resilience and preparedness will be paramount, as contemporary complex societies cannot afford to be ill-equipped in the face of external risks.

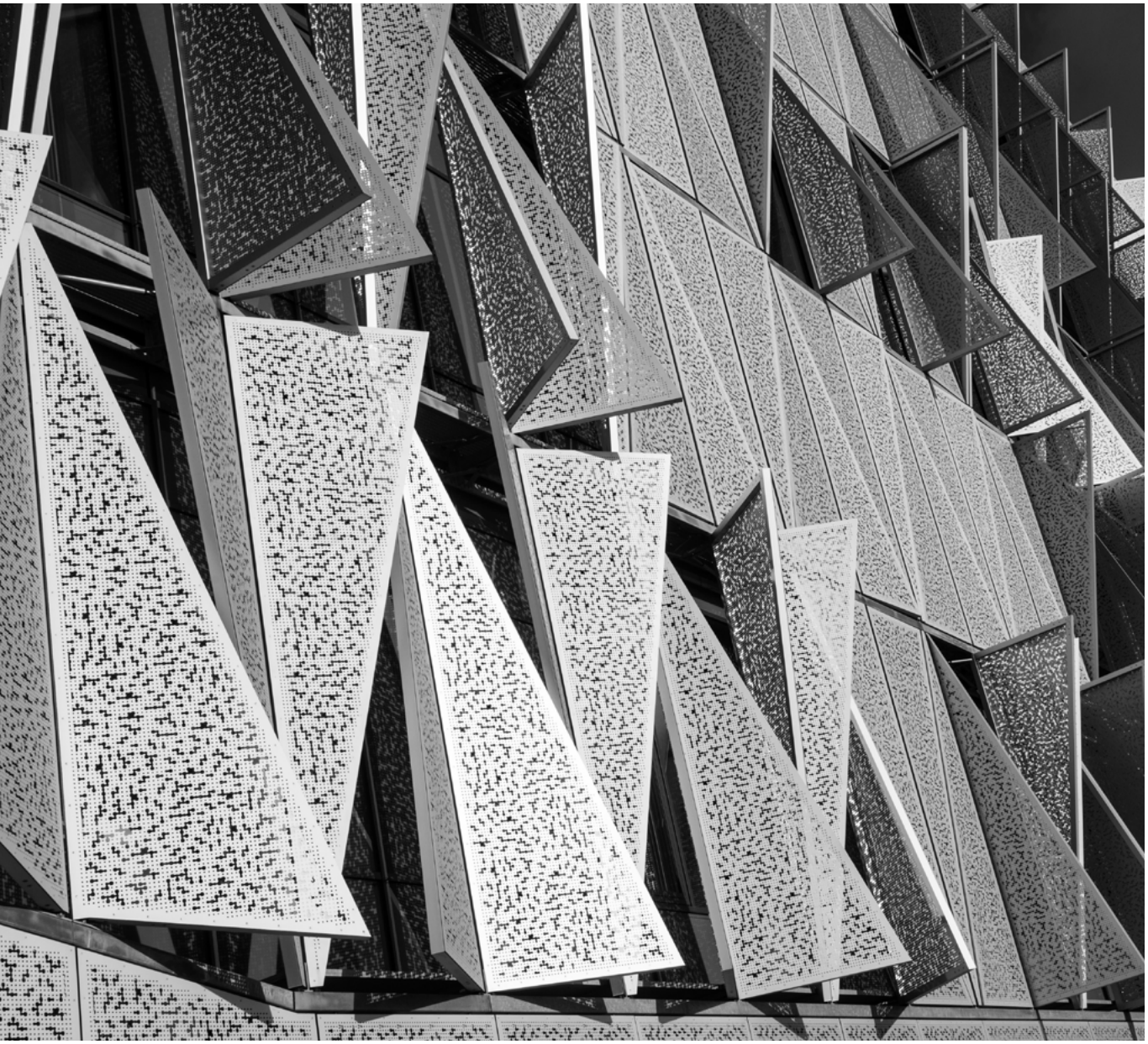
"It became clear that fostering business resilience in good times would help firms ride out crises, reduce the likelihood of bankruptcy and improve the state of the economy." - The International Trade Center (2020).

Or as former U.S. President John F. Kennedy is quoted to say: *"The best time to repair the roof is when the sun is shining."*

This report outlines our developed process model, which serves as a valuable tool for enhancing the resilience of Danish manufacturing SMEs. Alongside the process model, we have also included 32 specific tools that offer support throughout the implementation. One of the key messages derived from this project underscores the significance of internal dialogue and cross-functional involvement across various company departments, including sales, production, procurement, finance, IT, and product development. This collaboration ensures that the necessary areas are addressed to fortify the Supply Chain Resilience of the company (Stentoft & Mikkelsen, 2023).

We would like to extend our heartfelt gratitude to the individuals and organizations that contributed to the development of this process model. First and foremost, we express our sincere appreciation to the Danish Industry Foundation





for prioritizing this project and enabling its successful execution. Additionally, we would like to thank our steering committee, comprising Professor Per Vagn Freytag from the University of Southern Denmark, Kolding, CEO Søren Vammen from the Danish Purchasing and Logistics Forum, and CEO Tommy Christensen from JEVI A/S, for their unwavering commitment and valuable insights throughout the entire process. A special thanks goes to our colleague, Steen Thielsen, for generously allowing us to leverage his exceptional Excel skills, which resulted in the creation of a digital solution for inputting, prioritizing, and processing vulnerabilities and capabilities.

Furthermore, we would like to express our deep appreciation to the employees of Airco Process Technology, Baader Food Systems, Cubic Modulsystem, Ellepot, Exhausto, FarmDroid, Fredericia Furniture, KVM-Genvex, Linatech,

Logitrans, Odder Barnevogne, Pressalit, Sanovo Technology Group, SBS Friction, Tonica Elektronik, Vikan, Vitrolife, and Westrup for their active participation and valuable feedback throughout the process. Your constructive engagement and keen insights have been instrumental in ensuring the relevance and practicality of this report, process model, and accompanying tools. It has been an immensely enriching and enjoyable experience visiting your companies.

We also extend our heartfelt gratitude to Business House Fyn, Business House Capital, Business House Central Jutland, and Business House Northern Jutland for providing us with the invaluable opportunity to disseminate the project's process model and tools to your esteemed development consultants and representatives from the municipal business promotion system. Your support in sharing these resources will undoubtedly contribute to the broader benefit and practical application of our work.

We express our deep appreciation to COO Torben Madsen from SBS Friction and Supply Chain Manager Rasmus Otzen from Logitrans A/S for generously sharing their experiences as participants in the project's midway meetings in Ringsted and Kolding. Additionally, we extend our gratitude to Chief Consultant Kasper Hillgaard Mühlbach from Dansk Standard for attending both locations and delivering insightful presentations on how industry standards can aid companies in enhancing Supply Chain Resilience.

Likewise, we extend a big thank you to CEO Bo Borne Jørgensen from Westrup ApS and Supply Chain Specialist Cathrine Jørgensen from Exhausto A/S for their valuable contributions during the final conference in Slagelse. We would also like to acknowledge the significant contributions made by Production Manager Jonas Andreasen from KVM-Genvex A/S and Global Master Planner Lasse Rosing from CUBIC Modulsystem A/S, who delivered informative presentations during the final conference in Kolding.

We are grateful to the Danish Purchasing and Logistics Forum and the Horisont Group for their continuous support in disseminating the project's findings through DILFaktuelt and SCM+Logistik. Their dedication has been instrumental in raising awareness about our project.

Lastly, we would like to express our gratitude to the students at the University of Southern Denmark in Kolding - Asma Jasem, MSc. in Auditing, and Birta Maria Bjarnadóttir, BSc. in Digitalization and Business Development, for their invaluable assistance in identifying relevant company contacts for the survey. We also extend our thanks to Helena Sandberg Brovsting, BSc. in General Business Studies, and Emilie Locht, BSc. in Digitalization and Business Development, for their valuable contributions in processing qualitative data.

Jan Stentoft, Professor of Supply Chain Management
Ole Stegmann Mikkelsen, Associate Professor of Supply Chain Management
Tina Højrup Kjær, Communications Consultant

AIRCO
PROCESS TECHNOLOGY

Airco Process Technology

(Data collected during the autumn of 2022)

Airco Process Technology, founded in 2020 and headquartered in Fredericia, has experienced remarkable growth with over 100 employees and a continued upward trajectory. The company plays a vital role in future projects focused on carbon capture and the development of high-efficiency biogas upgrading plants, maximizing the utilization of resources.

Through technological innovation and the creation of pioneering solutions, such as unique carbon capture and biogas upgrading plants, Airco Process Technology enhances productivity while reducing costs through optimal resource utilization. With its significant growth, the company anticipates continued success.

During the project, Airco Process Technology diligently identified and addressed various vulnerabilities. These included challenges such as a shortage of human resources and dependence on key employees, lack of transparency, limited cross-functional collaboration resulting in organizational silos, and inadequate supplier capacity. To address these vulnerabilities, the company identified key capabilities to focus on. This involved increasing visibility at universities and vocational schools, enhancing employee branding, establishing an Airco Academy for comprehensive onboarding and training of new colleagues, standardizing and documenting work processes, implementing Sales & Operations Planning, and emphasizing deadlines to improve cross-functional collaboration. Additionally, Airco Process Technology undertook measures to identify alternative suppliers and enhance focus on critical components and inventory levels to address the issue of insufficient supplier capacity.

> ***Throughout the process, we collectively had several 'aha moments' that made us aware of how little we actually knew about each other's actions and behaviors. As a result, well-known sayings such as "We are never stronger than the weakest link in the (supply) chain" and "Together we are stronger" resonated profoundly in this context.***

- Dorte Aakær Jepsen, Project Manager, PMO, Airco Process Technology A/S

1 Introduction

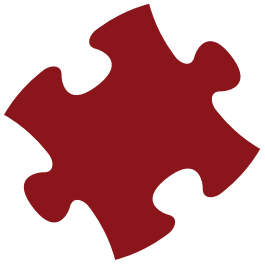
This first main section begins by providing an overview of the background for conducting the project titled "Supply Chain Resilience in small and medium-sized Danish manufacturing companies." Subsequently, it outlines the project's objectives and research questions.

1.1 Background

In December 2019, the first case of COVID-19 was reported in Wuhan, China. It rapidly spread, culminating in a global pandemic that had significant repercussions on supply chains at the global, regional, and local levels. Alongside the COVID-19 pandemic, other notable events have impacted supply chains. For instance, the grounding of the Taiwanese cargo ship Ever Given in the Suez Canal incurred estimated costs of 37 to 63 billion DKK per week for affected companies. Moreover, the invasion of Ukraine by Russia over a year ago resulted in a devastating war, posing challenges for various supply chains reliant on raw materials from Ukraine and Russia, the latter due to international trade boycotts. Additionally, record-breaking heatwaves in Southern Europe last summer caused a considerable decline in the water level of the Rhine, leading to disruptions in shipping along that route. Climate change and the closure of gas pipelines from Russia have contributed to significant increases in energy prices. Furthermore, inflation and interest rates have surged, exerting further strain on the economy. These disruptions have intensified the workload of supply chain professionals. Consequently, Supply Chain Resilience has gained substantial attention, prompting numerous companies to prioritize the development of their supply chains on their strategic agendas (Stentoft et al., 2023; Stentoft & Mikkelsen, 2021).

In addition to the aforementioned disruptions, global supply chains are facing the impact of escalating geopolitical tensions. These tensions have prompted a shift towards regionalization as a response to the previously prevailing trend of globalization (Stentoft & Mikkelsen, 2022). Moreover, supply chains are susceptible to various natural disasters, including earthquakes, volcanic eruptions, floods, tsunamis, terrorist attacks, and cybercrime. Furthermore, companies are currently grappling with significant pressures related to sustainability/ESG practices and compliance with multiple EU directives. Although companies recognize the importance and are willing to address these aspects, they often perceive them as administratively burdensome, especially for SMEs. Consequently, there are numerous compelling reasons for companies to intensify their efforts in establishing resilient supply chains.

The project places a particular focus on SMEs, which, in comparison to larger companies, typically possess fewer financial and human resources (Sullivan-Taylor & Branicki, 2011). Additionally, SMEs are generally less engaged in robust risk management practices (Brustbauer, 2016), and they often face challenges in allocating surplus resources such as extra inventory and engaging in interorganizational collaboration (Polyviou et al., 2020). A comprehensive literature review focused on Supply Chain Resilience from an SME perspective (Bak et al., 2023) highlights four key areas for development within



SME supply chains. These areas include:

1. Collaboration between companies: The review explores barriers and drivers for effective collaboration with key partners in supply chains. It delves into different implementation strategies for collaboration, such as contractual agreements, security measures, collaborative planning, process integration, and the depth of relationships in terms of collaboration.
2. Strengthening supply chain capabilities: This involves conducting single point of failure analyses, gaining a deeper understanding of production processes, managing customer portfolios, and improving communication systems within the supply chain.
3. Enhanced utilization of information systems: The review emphasizes the importance of optimizing the use of information systems to enhance Supply Chain Resilience within SMEs.
4. Managing Supply Chain Resilience with limited financial resources: Recognizing the financial constraints faced by SMEs, the review acknowledges the need to effectively manage Supply Chain Resilience with limited financial resources.

There is a consensus among researchers that there is a pressing need to strengthen SMEs in terms of Supply Chain Resilience (Drozdibob et al., 2022; Kamalahmadi & Parast, 2016; Polyviou et al., 2020).

1.2 Objectives and Research Questions

The project's objective is to identify and address vulnerabilities within the supply chains of Danish manufacturing SMEs, with the aim of significantly enhancing Supply Chain Resilience. The ultimate goal is to strengthen the target group and cultivate their ability to effectively handle diverse disruptions. The project aims to achieve this by providing participating SMEs with

knowledge, skills, and tools related to Supply Chain Resilience and risk management. Furthermore, the project aims to disseminate knowledge, facilitate knowledge transfer, and offer training to Danish small and medium-sized manufacturing companies.

To accomplish these goals, the project seeks to answer the following overarching questions:

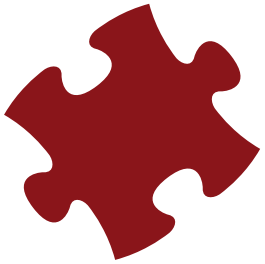
- How can greater resilience be fostered in SME supply chains?
- How should a focus on Supply Chain Resilience be organized in the SMEs?
- What are the drivers and barriers influencing the development of enhanced Supply Chain Resilience?
- What specific vulnerabilities do Danish manufacturing SMEs encounter within their supply chains?
- What capabilities are necessary for Danish manufacturing SMEs to effectively address these vulnerabilities?
- Which tools are relevant and beneficial for companies in strengthening Supply Chain Resilience?
- What is the current level of resilience within the supply chains of Danish manufacturing companies?

While the project primarily focuses on manufacturing companies, its results and insights are also applicable and relevant to other private and public companies across various sectors such as services, retail, and transportation.

Top-10 trends within Supply Chain Management in 2023

1. Big data & analytics
2. Digital supply chains
3. Supply chain risk & resilience
4. Artificial intelligence and machine learning
5. Robotics
6. Data security and cybersecurity
7. Circular and sustainable supply chains
8. Essential goods supply chains
9. Smart logistics and the internet of things (IoT)
10. Logistics vulnerability

Source: The Association for Supply Chain Management (2023).




BAADER

BAADER Food Systems Danmark A/S

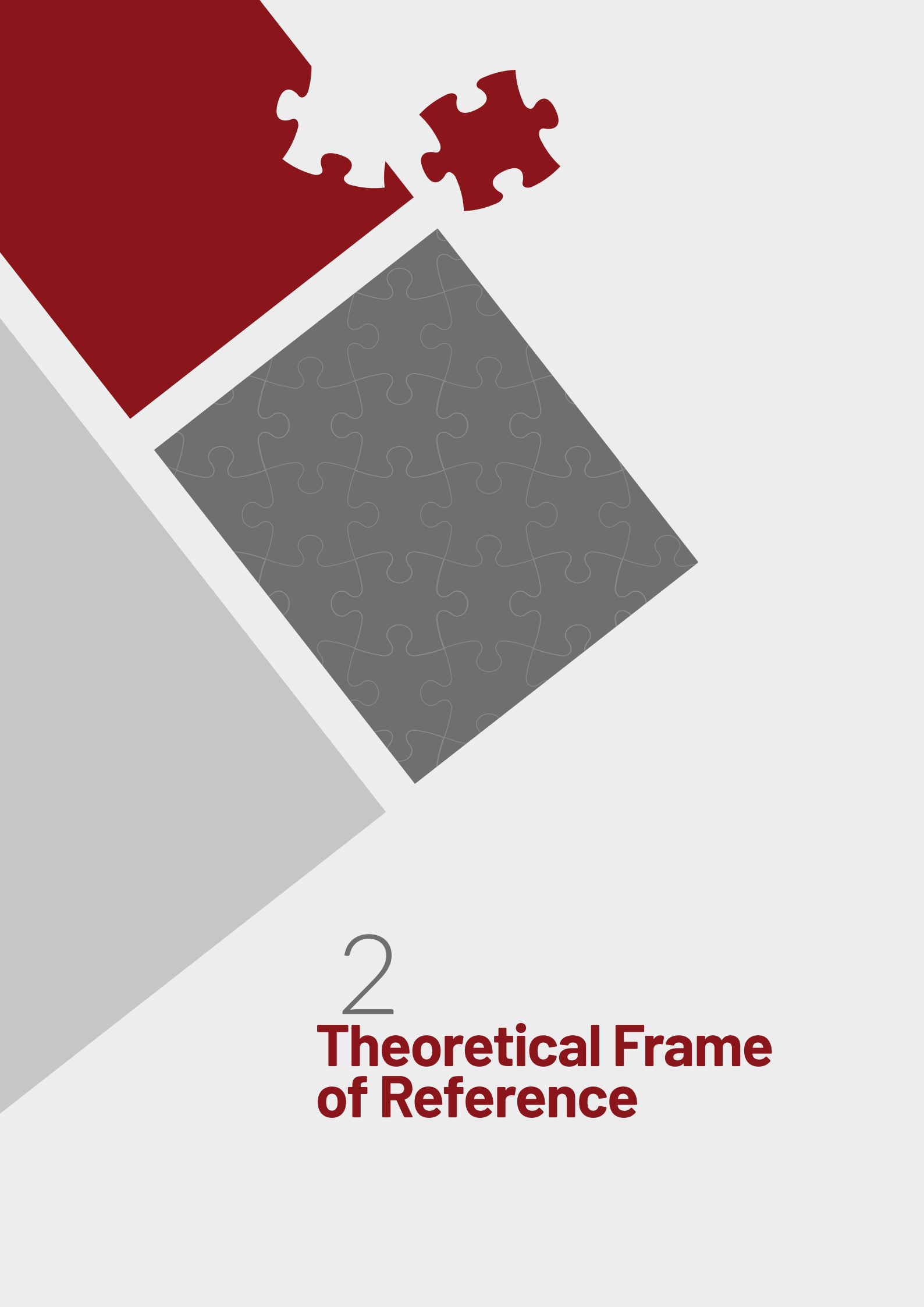
(Data collected during autumn 2022)

BAADER Food Systems Denmark, located in Trige, is part of the German company BAADER, a family-owned business with around 1,200 employees worldwide. BAADER specializes in the development, manufacturing, and marketing of process equipment for the food industry, ensuring efficient, precise, and gentle handling and processing of raw materials and finished products. The company places emphasis on animal welfare, food safety, and sustainability, and is working to digitize the value chain to ensure the most optimal process.

Throughout the project, BAADER identified several vulnerabilities that necessitated attention. These included challenges related to cross-functional collaboration, dependence on supplier relationships, and limited availability of raw materials and supplies. In response, a series of initiatives were identified to address these vulnerabilities. These initiatives focused on strengthening the supply chain strategy, fostering shared process understanding and knowledge sharing, exploring opportunities for product redesign and design for the supply chain, and standardizing selected component groups.

At BAADER, tools are being developed to support cross-organizational collaboration. Participation in the project has provided external validation that they are on the right track, while also highlighting areas for further improvement. The project's findings serve as a foundation for future Objective Key Results (OKR) initiatives. Currently, BAADER is engaged in cross-functional efforts to establish specific quarterly-focused OKRs, enabling a more targeted approach to areas of improvement and facilitating collaboration across the organization.

> ***BAADER Food Systems has participated in the Supply Chain Resilience project facilitated by SDU. It has been a great experience and has reaffirmed that our cross-organizational collaboration is heading in the right direction. We have realized the importance of having a supply chain strategy, particularly to ensure that all the functions within our company see themselves as significant players in optimizing the flow and strengthening the company.***
>
> - Jan Houlind Zoffmann Andersen, Production Director, BAADER Food Systems A/S



2
Theoretical Frame of Reference

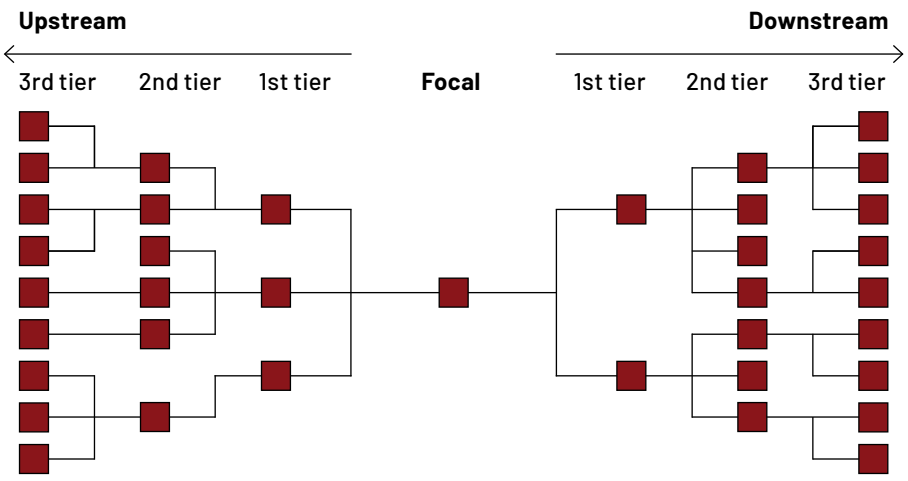
This section introduces the theoretical framework that underpins the entire project. Given the project's specific focus on small and medium-sized enterprises (SMEs), the subsequent section explores the unique characteristics associated with SMEs. We then proceed to examine Supply Chain Resilience in greater detail, encompassing key aspects such as definitions, various types of disruptions, drivers and barriers influencing resilience, risk management considerations, vulnerabilities within supply chains, and the necessary capabilities for building resilience.

2.1 Supply Chain Management

Supply Chain Management has become an important competitive factor for companies, as it focuses on both increasing revenue and reducing costs simultaneously. Examples of revenue-increasing initiatives include ensuring timely delivery of the right products in the right quality, demonstrating flexibility in order handling, providing real-time order status updates, and emphasizing the flow of materials, information, and finances within and between companies. Developing new distribution concepts to reach new customer segments is also a revenue-increasing initiative. Examples of cost-reducing initiatives include ensuring efficient inbound and outbound logistics, reducing procurement budgets, and minimizing the use of expedited transportation such as air freight. Supply Chain Management can be defined as:

"Transforming demand information to physical deliveries of goods and services. Supply Chain Management starts with customers' needs for goods and services that create demand for goods and services backwards in the supply chain and network. The key focus is on material, information, and financial flows unfolded in business processes. The management ideal is to provide a differentiated management of intra- and inter-organizational activities and processes with the purpose to fulfill customer requirements by delivering goods and services from the point of origin to the point of consumption at the overall lowest costs at the right time and at the highest required level of quality." - Stentoft et al. (2018, s. 28).

Figure 2.1: Supply chain network structure



Companies are participants in supply networks as shown in Figure 2.1. Within these networks, a specific company, known as the focal company, becomes the central focus of our analysis. Participants in supply chains can encompass various actors, such as consumers, retailers, wholesalers, transporters, manufacturers, the public sector, and consultants, among others. Activities preceding the focal company are referred to as upstream, encompassing suppliers, suppliers' suppliers, and so forth. These activities are represented as different tiers within the supply network, extending backwards. It is crucial for companies to cultivate an awareness of these upstream activities to identify vulnerabilities that may arise further back within the supply network, beyond just the immediate first-tier suppliers. Conversely, activities following the focal company are termed downstream, involving customers, customers' customers, and so on. While some companies operate within shorter and less intricate networks with only a few actors (e.g., bread production), others engage in expansive, global networks characterized by a high level of complexity (e.g., Airbus aircraft production).

2.2 Characteristics of Small and Medium-Sized Enterprises

SMEs play a pivotal role in the national economy, comprising 99.8% of all companies in the EU in terms of numbers (Eurostat, 2020). These enterprises typically employ between 10 and 250 individuals, with a turnover ranging from 10 to 50 million euros and a balance sheet total between 10 and 43 million euros (European Commission, 2020). Notably, SMEs contribute 55.9% to the national economy and employ 66.9% of the workforce (Eurostat, 2020). In comparison to large companies, SMEs generally possess limited financial and human resources. They often prioritize operational aspects at the expense of developmental activities and frequently have a managing director involved in day-to-day operations. SMEs also tend to have less experience in managing new technologies and adopt a more reactive approach to strategy (Zach et al., 2014). Table 2.1 provides a summary of additional characteristics associated with SMEs.

Tabel 2.1: Characteristics of SMEs

Limited financial and human resources
Visible and active top management
Few layers of management
Centralized decision-making
Short-term decision horizons
Intuitive decision-making processes
Simple, flatter, and less complex organizational structure
Lower degree of specialized employees
More flexible and agile processes
Informal rules and procedures
Low degree of standardization and formalization
Limited knowledge about IT
Limited strategic planning involving IT

Source: Based on Zach et al. (2014).

2.3 Supply Chain Resilience

The daily operations of Danish manufacturing SMEs can be disrupted by a wide range of factors. These disruptions encompass events that have a broad impact on supply chains, ultimately hindering the ability of companies to deliver products and services. Such disruptions can manifest in various forms, including:

- Pandemics
- Geopolitical unrest
- Climate changes
- Wars
- Strikes
- Inflation
- Currency exchange rate fluctuations
- Terrorism
- Cybercrime
- Shortage of qualified workforce

The concept of Supply Chain Resilience revolves around the development of adaptive capabilities that enable companies to prepare for unexpected events and effectively respond to disruptions, ultimately recovering to the same or

even improved levels compared to before the disruption occurred (Ponomarov & Holcomb, 2009). Recent empirical research has shown that the higher the level of Supply Chain Resilience embedded within a company, the more resilient the company is deemed to be (Stentoft et al., 2023). Christopher & Peck (2004) define Supply Chain Resilience as:

"The ability of a system to return to its original state or move to a new, more desirable state after being disturbed." - Christopher & Peck (2004).

Another definition of Supply Chain Resilience is:

"Supply Chain Resilience is the supply chain's ability to be prepared for unexpected risk events, responding and recovering quickly to potential disruptions to return to its original situation or grow by moving to a new, more desirable state in order to increase customer service, market share and financial performance." - Hohenstein et al. (2015).

The definition by Hohenstein et al. (2015) expands the focus to also include growth and performance areas.

2.3.1 Vulnerabilities and Capabilities

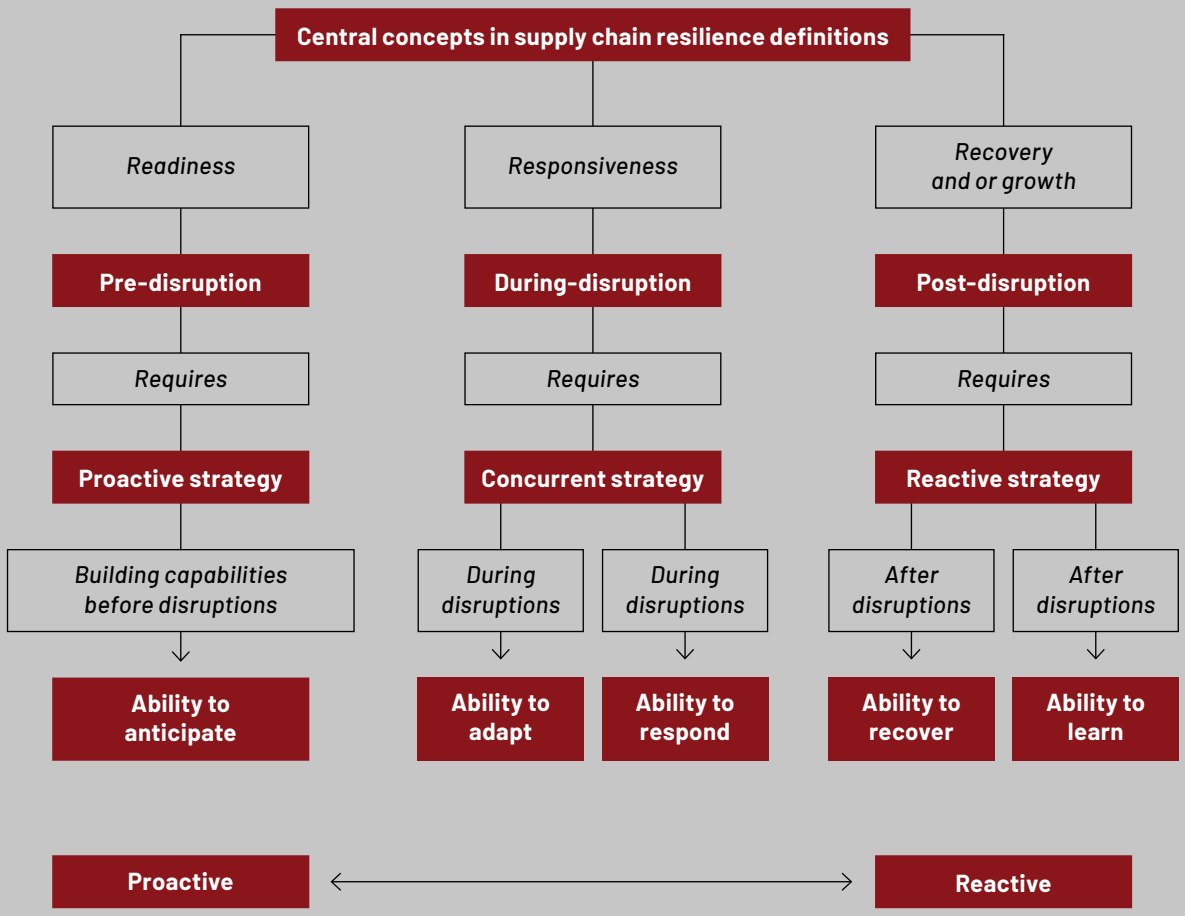
According to Jüttner et al. (2003), supply chain vulnerabilities refer to the risks that arise from disruptions within the supply chain due to inadequate security measures. These vulnerabilities encompass the fundamental factors that render a company susceptible to disruptions, including intentional threats and resource scarcity (Pettit et al., 2013). On the other hand, capabilities can be understood as the qualities that enable a company to anticipate and over-

Table 2.2: Proactive capabilities and Supply Chain Resilience practices

Strategy	Capability	Elements	Practices
Proactive	Ability to anticipate	Situation awareness	Sensing and interpreting events, continuity planning, mapping of supply chain vulnerabilities, warning strategies, risk avoidance and containment, risk control/transfer/share.
		Robustness	Supply chain network design: supply chain/infrastructure configuration, segmentation, decentralization, density, complexity, node/location criticality, product flow, product design, supply base strategy, anticipation/preparedness to changes.
		Increasing visibility	Monitoring performance (KPI metric and measurement), IT capabilities, information sharing, transparency through integrated systems, connectivity.
		Building security	Freight/physical security, security culture, countermeasures for counterfeiting threat, cyber-security, layered defenses, creating public–private partnerships (PPP), cooperative strategies with supply chain partners.
		Knowledge management (pre-disruption)	Supply chain understanding, education and training, supply chain drills, simulations and exercises, SCRM/SCRES culture, board-level leadership, risk-management department, risk awareness, inter-organizational learning.

Source: Ali et al. (2017).

Figure 2.2: Key concepts in Supply Chain Resilience definitions



Source: Based on Ali et al. (2017).

come disruptions (Pettit et al., 2010). These capabilities can take various forms, such as preventing disruptions, mitigating their impact, and/or enabling the company to adapt.

Ali et al. (2017) conducted an extensive review of the literature on Supply Chain Resilience, encompassing numerous proposed definitions. Figure 2.2 presents an overview of their work, distinguishing between different capabilities and practices across three phases of the resilience journey: 1) pre-disruption, 2) during the disruption, and 3) post-disruption.

Prior to a disruption, it is essential to establish readiness, which entails adopting a proactive strategy that involves building new capabilities or enhancing existing ones. These capabilities encompass the ability to predict potential disruptions, increase alertness to early warning signals, ensure robustness in

Table 2.3: Concurrent capabilities and Supply Chain Resilience practices

Strategy	Capability	Elements	Practices
Concurrent	Ability to adapt	Increasing flexibility	Flexible supply via multiple suppliers, flexible manufacturing processes or resources, flexible product via postponement, flexible pricing via responsive pricing, flexible transportation mode, flexible order fulfilment.
		Building redundancy	Excess capacity in production or transportation or resources, multiple suppliers, safety stock, strategic inventory, emergency backup/storage facilities, low capacity utilization.
	Ability to respond	Collaboration	Collaborative planning, supply chain intelligence, information sharing, coordination, coopetition with competitors.
		Agility	Velocity and acceleration, responsiveness, speed.

Source: Ali et al. (2017).

operations, enhance visibility across the supply chain, incorporate security measures, and prioritize effective knowledge management (refer to Table 2.2 for a detailed overview).

During a disruption, it is imperative to respond rapidly, necessitating the adoption of a concurrent strategy that encompasses adaptation and counter-response capabilities (refer to Table 2.3 for an overview). Specifically, this entails fostering flexibility and incorporating redundant resources, such as multiple suppliers of the same unique raw materials. Collaboration and agility also play a crucial role in effectively managing disruptions.

Once a disruption has occurred, the focus shifts towards rebuilding the affected business areas to the same or even better levels, along with potential further growth (see Table 2.4 for details). Reactive strategies come into play, emphasizing countermeasures, recovery, and growth through vigilance (the ability to identify disruptions in a timely manner) and agility (the ability to counter disruptions through process changes). Throughout this project, in which we have worked closely with 18 case companies, we have observed that positive outcomes can arise from a COVID-19 crisis, such as the opportunity to reassess and change suppliers, which may not have been feasible during the demands of everyday operations. This has ultimately led to performance improvements.

2.3.2 Drivers and Barriers

Ali & Gölgeci (2019) conducted an extensive literature review examining the drivers that motivate companies to engage with Supply Chain Resilience. Their study identified a total of 22 drivers, which can be categorized into three main groups: 1) ensuring readiness, 2) ensuring resilience, and 3) bouncing back. Similarly, Pereira et al. (2014) conducted an in-depth literature review and identified various barriers that companies encounter when working on Supply Chain Resilience. Both the drivers and barriers are presented in Table 2.5. It is

important to note that in addition to the listed barriers, the aforementioned characteristics of SMEs, such as limited financial and human resources, can also be perceived as barriers. As indicated in Table 2.5, the literature highlights several recurring drivers for Supply Chain Resilience, including achieving flexibility, collaboration, surplus capacity, visibility, robustness, agility, resource restructuring, and adaptation. On the other hand, significant barriers to creating Supply Chain Resilience include lack of information, complexity, inflexibility, limited capacity, and inadequate collaboration.

2.3.3 Creating Supply Chain Resilience

Christopher & Peck (2004) outline four main steps in establishing resilient supply chains: 1) supply chain reengineering, 2) supply chain collaboration, 3) agility, and 4) supply chain risk management culture.

Supply Chain Reengineering. The first step involves gaining an understanding of the current situation. What is the current supply chain design? Previous decisions shape the specific design of the supply chains, including decisions regarding outsourcing, warehouse locations, choice of suppliers, and more. Supply chain design relates to decisions such as the location of production sites, the number and sizing of warehouses, the choice of distribution channels, the selection of push/pull points in the supply chains, the design of reverse logistics systems, e-commerce solutions, new service business models using Industry 4.0, and the design of supply networks (single, dual, multiple sourcing). In this work, it is recommended to map the supply chains (Farris, 2010; Gardner & Cooper, 2003; Lambert & Cooper, 2000). In this initial phase, it is also important to examine the existing supply strategy. How many suppliers are being used? Where are they located? What is the extent of single, dual, and multiple sourcing?

Supply Chain Collaboration. Information exchange between partners in the supply chains can reduce risks. The key question then becomes, with whom and with which information should this exchange take place? It is a

Table 2.4: Reactive capabilities Supply Chain Resilience practices

Strategy	Capability	Elements	Practices
Reactive	Ability to recover	Contingency planning	Supply chain reconfiguration, resource reconfiguration, recovery plans, restoration plans, time to market, scenario analysis.
		Market position	Financial strength, market share, efficiency, strategic alignment, adaptability, customer relationships, customer communications.
	Ability to learn	Knowledge management (post-disruption)	Education and training, post-disruption feedback, cost/benefits knowledge, becoming a learning organization, looking beyond risks to see opportunities, increasing innovativeness in contingency planning and continuity management.
		Building social capital	Trust, inter-organizational relationships, relational competence, leverage co-creation processes.

Source: Ali et al. (2017).

Table 2.5: Drivers and barriers for working with Supply Chain Resilience

Drivers		Barriers
Preparedness		*Lack of information (77%)*
	Supply chain flexibility (38%)	Complexity (73%)
	Supply chain collaboration (30%)	Lack of flexibility (70%)
	Redundancy (19%)	Lack of capacity (57%)
	Resilience culture (17%)	Lack of collaboration (50%)
	Information sharing (16%)	Long lead-times (43%)
	Supply chain innovation (12%)	Lack of visibility (37%)
	Top management support (6%)	Lack of coordination and control (37%)
	Employees training and development (3%)	Lack of knowledge (30%)
	Public-private partnerships (3%)	Long distances (27%)
	Co-opetition (2%),	Financial weakness (16%)
	Industry 4,0 (2%)	Lack of integration (13%)
	Big data analytics (2%)	Lack of trust (13%)
	Block chain technologies (0,6%)	
Resistance		
	Visibility (32%)	
	Robustness (28%)	
	Agility (26%)	
	Velocity (6%)	
Rebound		
	Resource reconfiguration/mobilization (31%)	
	Adaptation (20%)	
	Disruption mitigation (18%)	
	Supply chain redesign (6%)	
	Additive manufacturing (0,6%)	

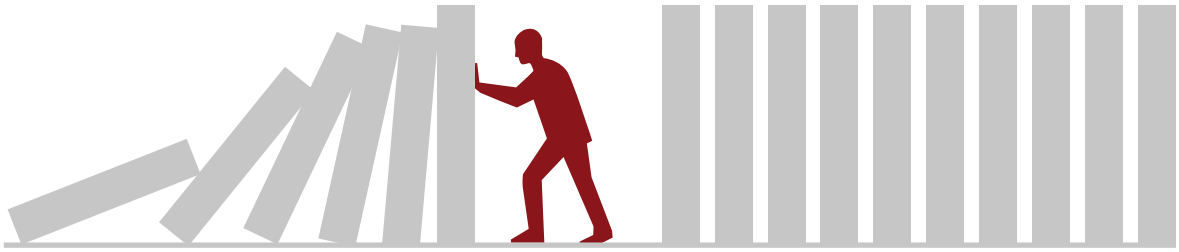
Source: Ali & Gölgeci (2019) and Pereira et al. (2014).
Note: The numbers in parentheses indicate the percentage of the reviewed material in which the drivers and barriers are discussed.

general supply chain practice to strive for differentiated work with different supply chain solutions (Stentoft et al., 2018). A company with, for example, 400 suppliers cannot work with all of them intensively. That is why portfolio models have been developed to help differentiate work with materials and suppliers. However, the COVID-19 pandemic has made it clear that no chain is stronger than its weakest link. Therefore, it is important to be aware that simply segmenting suppliers and only sharing information with those seen as strategic suppliers may not be sufficient.

For SMEs, with their limited resources, it may be worth considering organizing themselves into networks, such as through industry associations, where they can collaborate with multiple companies on early warning signals in the supply chains (e.g., establishing control towers focused on collecting developments in raw material prices, inflation rates, and political decisions).

Agility. The more agile a supply chain is, the faster it can recover. Visibility and speed are two key catalysts for agility. Visibility is about being able to see from one end of the supply chain to the other. This can involve inventory levels, supply and demand conditions, and production and procurement plans. Transparency is achieved through collaboration with supply chain partners and through internal organizational integration. Speed focuses on distance over time. To increase speed, time consumption in processes must be reduced (streamlined), and non-value-adding activities must be minimized or eliminated.

Supply Chain Risk Management Culture. Resilience does not come naturally; it requires the attention and support of top management. Building a risk management culture requires sustained effort, keeping in mind Peter Drucker's famous quote, "Culture eats strategy for breakfast." This culture should not only be anchored in one function within the company but across functions including sales, production, procurement, finance, IT, and development. Christopher & Peck (2004) suggest the establishment of a cross-functional supply chain business continuity team working in formalized processes with risk management. This way, risk management becomes something that is worked on proactively rather than reactively after a disruption has occurred. Pettit et al. (2013) also emphasize the importance of adopting a broad company perspective on Supply Chain Resilience, involving cross-functional participation and participants at different organizational levels to address both strategic and operational aspects.



CUBIC

A ROCKWELL AUTOMATION COMPANY

CUBIC Modulsystem A/S

(Data collected during the autumn of 2022)

CUBIC Modulsystem A/S was established in 1973 with a unique concept of a modular system for switchboard construction. Over the years, this idea has transformed CUBIC into a globally recognized electromechanical partner, offering a comprehensive range of enclosure solutions. The company's headquarters are located in Brønderslev, Denmark, where it employs 250 people, including 100 office workers and 150 hourly workers.

CUBIC's solutions find applications across various industries, including mining, airports, ships, data centers, hospitals, power plants, and wind turbines, among others.

The company has faced challenges due to its dependence on suppliers' suppliers. For example, CUBIC has its own-developed screws produced by a supplier's supplier in Taiwan. However, its immediate supplier struggles to effectively meet CUBIC's needs, despite the latter's stable demand. CUBIC also experiences the bullwhip effect when its customers, particularly large ones, encounter issues at their foreign factories, impacting CUBIC's operations.

Through the project, several areas of focus have been identified. These include developing robust sales forecasts, establishing processes for knowledge sharing, creating visibility for potential employees through collaborations with universities, engineering studies, and job centers, as well as developing a competence matrix to identify untapped competencies within the supply chain.

> ***We have embarked on an informative and positive project journey that has shed light on key areas of focus. Simultaneously, we have become more receptive to leveraging the insights gained throughout the process and adopting a cross-organizational approach to our risk management practices.***

- Lasse Rosing, Global Master Planner, CUBIC Modulsystem A/S

2.4 Supply Chain Risk Management

Risk refers to the potential for undesirable negative consequences resulting from events, while resilience represents the system's or organization's capacity to prevent, withstand, and recover from such events (Slack et al., 2013).

Risk management involves:

1. Identification and assessment of potential events and their impacts.
2. Prevention of events.
3. Mitigation of impacts - minimizing the adverse consequences of events.
4. Recovery after events.

Supply chain risk is determined by the probability and impact of an event or disruption (Christopher, 2016). In other words:

Supply chain risk = probability of occurrence x impact.

The probability and impact can vary from very low to very high. Therefore, risk management efforts aim to either reduce the likelihood of events occurring or minimize the negative consequences when they do occur. Table 2.6 shows an example of a scoring system for risk analysis.

Risks in supply chains can stem from various sources. They can originate from the external environment in which the supply chains operate. Additionally, risks can arise externally to the company but internally within the supply chains, such as supply-related risks and demand-related risks.

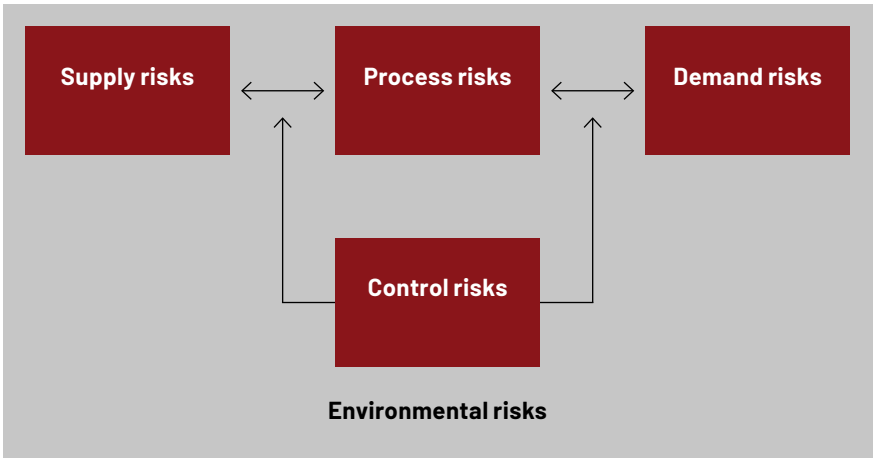
Finally, risks can be attributed to internal organizational factors. The risks in supply chains can be classified into at least five categories, as illustrated in Figure 2.3, based on the work of Christopher & Peck (2004).

Table 2.6: Scoring system for risk analysis

Seriousness	1. No direct effect on operating service level 2. Minor deterioration in operating service level 3. Definite reduction in operating service 4. Serious deterioration in operating service level 5. Operating service level approaches zero
Probability of occurrence	1. Probability of once in many years 2. Probability of once in many operating months 3. Probability of once in some operating weeks 4. Probability of weekly occurrence 5. Probability of daily occurrence

Source: Christopher (2016, p. 228).

Figue 2.3: Supply chain risk sources and categories



Source: Christopher & Peck (2004).

Internal to the company:

5. Process risks

6. Control risks

External to the company but internal to the supply network:

7. Demand risks

8. Supply risks

External to the supply network:

9. Risks in the external environment of the supply network

Processes are sequences of activities performed to accomplish a task and rely on resources and actors (Christopher & Peck, 2004). Errors can occur in process and operational management. For example, the design of a production process can lead to bottlenecks and the accumulation of goods in progress. Control systems encompass the rules, procedures, and systems used by a company to manage and monitor its processes, such as safety stock and order sizes (Christopher & Peck, 2004).

Errors can therefore arise from how these control systems are utilized, misused, or neglected. The internal performance system, for instance, may have inherent sources of errors where different Key Performance Indicators have conflicting objectives. Supply risks relate to errors in the timing, quantity, or quality of products, services, or information from the supply side. This can include late deliveries causing production downtime or poor quality in delivered products. It may also involve suppliers failing to comply with human rights or being environmentally damaging, which can harm the buyer's reputation.

Demand risks are associated with errors in products, information, and payments from the customer. Typically, these errors stem from internal errors within the company (process and control risks) or errors related to the supply side. However, one should not overlook the errors that can arise from

> ***The probabilities of known risks can be estimated based on their impact on the company. Unknown risks, on the other hand, are challenging to predict. An unknown and less predictable risk is, for example, COVID-19.***

the customer's incorrect use of the product, which should be considered in product design (Slack et al., 2013).

Environment-related risks pertain to risks that the company cannot effectively influence or can only influence to a limited extent. Extreme examples of these risks include pandemics like COVID-19, the war in Ukraine, or natural disasters. However, they can also include more common risks like cybercrime or new legislation. Some risks are predictable, while others are less predictable. Known risks can be identified, measured, and managed. For instance, a known and predictable risk for a last-mile operator is the increasing bans and restrictions of diesel vehicles in city limits.

The probabilities of known risks can be estimated based on their impact on the company. Unknown risks, on the other hand, are challenging to predict. COVID-19 serves as an example of an unknown and less predictable risk.

Table 2.7: Supply chain risks

Supply risks	Process risks	Demand risks	Control risks	Environmental risks
▸ Outsourcing and globalization ▸ Supplier commitment ▸ Variability of replenishment lead time ▸ Supplier bankruptcy ▸ Poor logistics performance of suppliers ▸ Sudden hike in costs ▸ Supplier insolvency ▸ Supplier quality problems ▸ Sudden supplier demise ▸ Capacity fluctuations or shortage in supply market	▸ Machine failure ▸ Product quality problems ▸ Labor strike ▸ Breakdown of external or internal IT infrastructure ▸ Equipment unreliability ▸ Operator unavailability ▸ Bottleneck or inflexible processes ▸ Reliability of supporting communication system	▸ Volatile demand ▸ Market changes ▸ Innovative competitors ▸ Forecasting errors ▸ Unusual customer payment delays ▸ Unanticipated demand ▸ Competition changes ▸ Insufficient information from customer order	▸ Lack of collaborative planning ▸ Safety stock policy ▸ Poor visibility along the supply chain ▸ Transportation management policy ▸ Batch size or order quantity policy ▸ Asset management policy ▸ Asymmetric power relationships	▸ Natural disasters ▸ Terrorism and war ▸ Political instability ▸ Social and political grievance ▸ Technological changes ▸ Diseases or epidemics ▸ Economic downturn

Source: Shekarian & Parast (2021).

Traditional risk management approaches are limited in addressing unknown risks. The following quote from former U.S. Secretary of Defense Donald Rumsfeld is included to exemplify unknown risks, or rather, unknown unknowns:

"Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tends to be the difficult ones." - Donald Rumsfeld, former U.S. Secretary of Defense, 2002.

We refer to Tool 15, titled "Known and Unknown Risks and Known and Unknown Impacts," for specific examples of how to address such risks. Additionally, Table 2.7 provides several examples of supply chain risks. To gain a comprehensive understanding of different types of risks, we recommend referring to Tool 13, which offers an overview that can help assess their relevance to your specific situation and practice. Once you have identified and assessed the different types of risks, it is essential to make decisions regarding how to address them. There are several strategies that can be employed based on the nature of the risks:

Eliminate risks
Remove the sources of risks, such as redesigning products to eliminate dependencies on specific critical raw materials and/or suppliers.

Mitigate risks
Reduce the likelihood of risks occurring or their impact. This can be achieved, for example, by establishing alternative suppliers (dual or multiple sourcing).

Transfer risks
Partially or entirely transfer risks to other parties through contracts, insurance, or hedging.

Accept risks
Choose not to take specific actions but be aware of the risks. In such cases, contingency plans should be developed to mitigate the potential impact. Some companies in our project have recognized the presence of sole suppliers among their direct suppliers and have chosen to accept this risk. However, this awareness has also prompted them to initiate efforts in identifying alternative suppliers.

Pujawan & Bah (2022) have examined how supply chain mitigation strategies have evolved after the COVID-19 pandemic. As shown in Table 2.8, there is now a greater emphasis on local sourcing from multiple suppliers, fostering surplus capacity, and strengthening information sharing within supply chains.

Table 2.8: Mitigation strategies

Area	Disruption mitigation strategies mentioned before COVID-19	Disruption mitigation strategies mentioned after COVID-19
Supply management	▸ Diversify supply ▸ Backup supply ▸ Protected suppliers ▸ Changing supply plan ▸ Risk sharing contract ▸ Dual sourcing	▸ Multiple, flexible, and alternative suppliers ▸ Near or local sourcing ▸ Source local substitutes ▸ Localizing the supply base/ supply chain
Inventory buffering	▸ Stockpile inventory ▸ Prepositioned inventory ▸ Redundant stock ▸ Strategic stock	▸ Inventory buffering ▸ Lean resilience
Supply chain flexibility	▸ Postponement ▸ Changing product configuration ▸ Change in pricing strategy ▸ Alternative transportation modes ▸ Transportation route flexibility	▸ Supply chain flexibility ▸ Capacity redundancy
Information acquisition, processing and visibility	▸ Strategic information acquisition	▸ Supply chain visibility ▸ Improve information visibility ▸ Active information sharing throughout the supply chain ▸ Information processing capabilities
Digitalization	-	▸ Supply chain digitalization ▸ Digital twin

Source: Pujawan & Bah (2022).

ELLEPOT®
GROW SMARTER

Ellepot A/S

(Data collected in late 2021/early 2022)

Ellepot, founded in 1993 and headquartered in Esbjerg, is a company that specializes in the development, manufacturing, and sale of cultivation systems for nurseries and forestry companies. With approximately 75 employees, Ellepot's flagship product is the "Ellepot," a soil-filled paper pot that offers faster and more uniform plant germination, along with efficiency gains and increased flexibility for growers. Unlike plastic pots, the biodegradable Ellepots allow plant roots to breathe and decompose when planted.

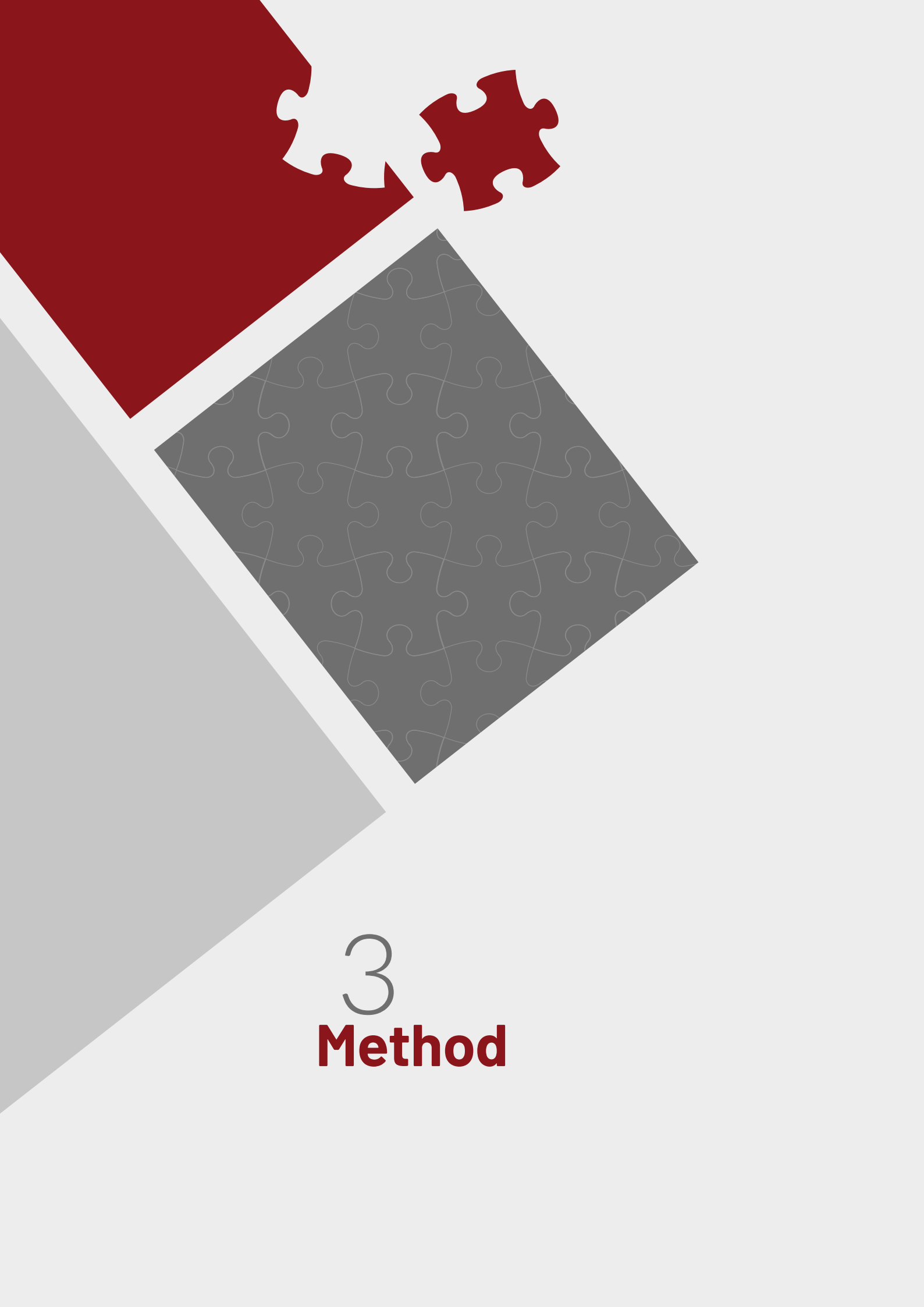
Ellepot's product range includes customized machines for Ellepot production, a variety of paper types tailored to specific plant cultures, and propagation trays. The company has a global presence, serving customers in over 130 countries, with 98% of its sales being export-oriented. With an annual production of approximately 8 billion Ellepots worldwide, Ellepot is recognized as a sustainable alternative to plastic pots, which still dominate 90% of the market.

During the COVID-19 pandemic, Ellepot experienced significant growth as customers sought automated and larger machines for Ellepot production. However, the company also faced challenges related to price increases, longer lead times, and supply chain disruptions. Travel restrictions posed obstacles for technicians assembling machines at customer sites.

Participating in the project helped identify vulnerabilities in areas such as human resources, availability of standard raw materials and supplies, dependency on unique raw materials, and production and distribution capacity. In response, Ellepot implemented targeted initiatives to develop reserve capacity, optimize production processes, improve forecasting accuracy, and enhance knowledge sharing.

> ***The project facilitated a shared understanding of our key challenges, leading to stronger and more focused efforts. Over a year later, it is evident that the review and improvements have positively impacted various processes and functions within our company.***

- Kenneth Kruse Smedegaard, Procurement Manager, Ellepot A/S



3
Method

3.1 First Company Iteration – Development of a Process Model (Exploration)

The project's results were obtained through two phases of company participation. The first phase occurred from October 2021 to May 2022, during which the COVID-19 pandemic caused some meeting cancellations and postponements.

The following eight companies participated in the first phase:

- Ellepot A/S
- FarmDroid ApS
- KVM-Genvex A/S
- Logitrans A/S
- SBS Friction A/S
- Tonica Elektronik A/S
- Vikan A/S
- Vitrolife A/S

Initially, the plan was to involve ten companies in the process, but two had to withdraw due to their increased focus on daily operations and supply chain challenges caused by COVID-19.

The first phase of the company iteration focused on development and consisted of three days spent in each participating company, followed by a joint

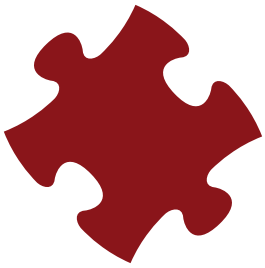
closing day at the University of Southern Denmark in Kolding. On the first day, individual interviews were conducted with key employees from various departments, including sales, production, procurement, logistics, finance, IT, and product development. The objective was to gain insights into their functional areas and the specific challenges they faced due to the pandemic. All interviews were recorded and transcribed.

On the second day, the project team presented and provided feedback on the structure of the company's supply chains and the challenges they were facing. This was followed by a workshop where employees individually worked to prioritize vulnerabilities and capabilities printed on red (vulnerabilities) and green (capabilities) cards made of cardboard.

The list of vulnerabilities and capabilities was derived from a master list of 41 vulnerabilities and 71 capabilities translated from English to Danish based on Pettit et al.'s work (2013). Each employee identified and ranked the critical vulnerabilities for their company and then selected the corresponding capabilities needed to address those vulnerabilities.

Figure 3.1 shows an example of prioritization, where the vulnerability with the highest priority was identified as "Supplier, Production, and Distribution Capacity," and the chosen capabilities to address this were "Forecasting," "Reserve Capacity," and "Creative Problem Solving."

Figure 3.1: Manual process with cards in the first iteration



Following the completion of the card exercise, each employee was interviewed about their prioritization work, and these interviews were recorded and transcribed. On the third day, the project group presented the results of the individual choices of vulnerabilities and capabilities to the employees. The task then involved the employees jointly prioritizing among the selected vulnerabilities and reaching a final list of prioritized vulnerabilities and capabilities through group discussion. The number of vulnerabilities and capabilities identified and prioritized varied significantly among the companies, resulting in a maximum selection of 10 vulnerabilities and five capabilities per vulnerability in the final process model. This allowed for a more focused and refined prioritization.

On the fourth day, representatives from the eight companies gathered at the University of Southern Denmark in Kolding for a review of the first three days. Here they evaluated the process, discussed the identified vulnerabilities and capabilities, and addressed any redundancies or missing elements. The discussion also revolved around the need for specific tools to support the process and the importance of action plans and prioritization of development activities within the busy daily routine of the companies. A valuable feedback received on that day was that some companies felt somewhat left on their own after the third day and expressed a need for an additional day to consolidate the identified vulnerabilities and capabilities into a more solid action plan. The companies also had the opportunity to exchange experiences with each other and discuss the challenges they were currently facing, hindering their progress.

3.2 Second Company Iteration – Test of the Process Model

The second iteration with companies was conducted from August 2022 to January 2023, involving the participation of 10 companies:

- Airco Process Technology A/S
- Baader Food System A/S
- CUBIC-Modulsystem A/S
- Exhausto A/S
- Fredericia Furniture A/S
- Linatech A/S
- Odder Barnevognsfabrik A/S
- Pressalit A/S
- Sanovo Technology Group A/S
- Westrup ApS

The second round aimed to test the developed process model and make further refinements. To facilitate the collection and prioritization of vulnerabilities and capabilities, an Excel solution was developed over the summer of 2022.

This digital solution replaced the physical card version, allowing for easier data processing and practical application. However, the physical card version was valuable for testing the effectiveness of the predefined vulnerabilities and capabilities approach.

After the first iteration, participants were sent an electronic questionnaire to evaluate the 41 vulnerabilities and 71 capabilities using a five-point Likert scale. They were also given the opportunity to suggest new vulnerabilities, capabilities, and specific tools. Based on this feedback, the project group defined an

Table 3.1: Functions represented in the testing phase with 10 companies

	Airco Process Technology	Baader Food System	CUBIC Modulsystem	Exhausto	Fredericia Furniture	Linatech	Odder Barnevognsfabrik	Pressalit	Sanovo Technology Group	Westrup
CEO						X		X		X
COO					X		X	X		X
Sales	X	X	X	X	X	X	X	X		X
Distributor Channel Manager									X	
Business Specialist			X							
Project Department		X	X							
Supply Chain				X					X	
Production	X	X	X	X	X	X	X	X		
Spareparts Manager										X
Planning			X					X	X	
Purchasing	X	X	X	X	X	X	X	X		
Category Manager									X	
Finance/IT	X	X	X	X	X	X	X	X	X	X
Product Development	X	X		X		X	X	X	X	X
Supply Chain Resilience					X					

updated set of 75 vulnerabilities and 97 capabilities, which were incorporated into the electronic solution. The process model was further refined, providing more concrete content for the four phases of the model.

During the second round, the 10 participating companies were visited three times. Table 3.1 shows which functions in the companies that have been part of the process. The first day involved joint mapping of the company's supply chains. On the second day, participants individually identified and prioritized vulnerabilities and capabilities using the electronic process model. On the second day at the company, the participants had to work together on the identification and prioritization of vulnerabilities and capabilities in the electronic process model towards a joint prioritized list The final day at the company focused on developing action plans to address the prioritized vulnerabilities and strengthen the required capabilities.

EXHAUSTO

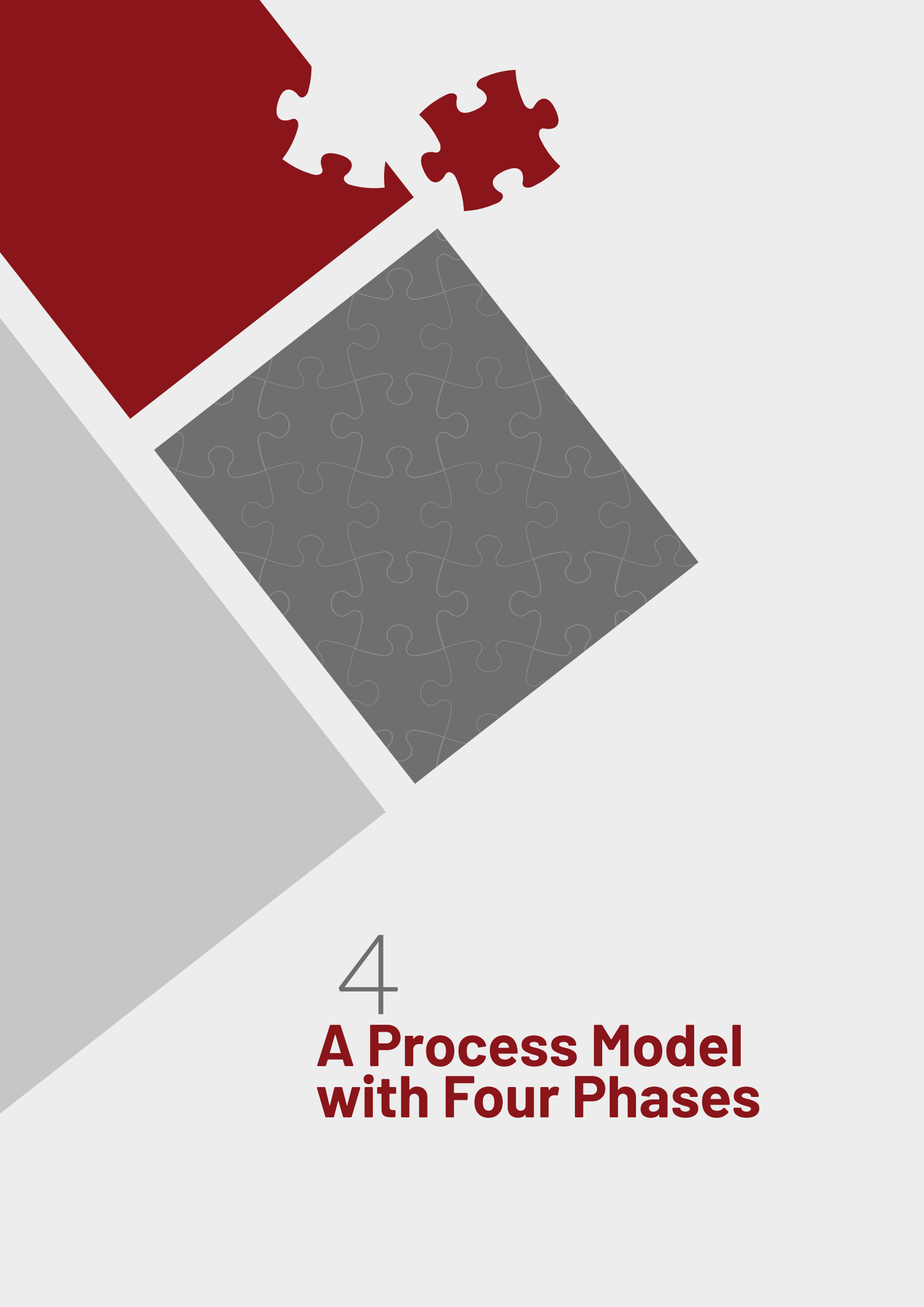
EXHAUSTO A/S

(Data collected during the autumn of 2022)

Since its establishment in Sorø in 1957, EXHAUSTO has grown into a leading supplier and partner in ventilation solutions. In 1963, the company relocated to Langeskov on the island of Funen, where its headquarters are currently situated. With a workforce of 315 employees, EXHAUSTO operates production facilities in Langeskov and Flå, Norway, and maintains sales subsidiaries in Denmark, Norway, Sweden, and Germany. In 2016, EXHAUSTO became part of the French ALDES Group. The company specializes in developing and manufacturing high-quality products and systems for comfort ventilation, aiming to set new industry standards in terms of energy efficiency and performance.

Throughout the project, EXHAUSTO identified and addressed various vulnerabilities and capabilities. Vulnerabilities included challenges related to the availability of qualified workforce and generational issues in production, dependency on suppliers, lack of cross-functional collaboration, scarcity of raw materials, and unpredictable customer demand. EXHAUSTO also encountered frequent changes in customer orders, leading to a significant number of rescheduling activities. In response, the project team highlighted several capabilities that needed development and emphasized their importance. These included allocating additional resources, fostering internal collaboration and communication, clarifying roles and responsibilities with suppliers, modularizing products, and improving master data management and forecasting. While unpredictable customer demand is beyond the company's control, efforts are being made to modularize products and reduce lead times with suppliers.

> ***By utilizing the SC-resilience tool developed by Jan Stentoft and Ole Stegmann Mikkelsen, our organization has gained a shared understanding of the vulnerabilities affecting our ability to meet customer expectations and the initiatives required to minimize these vulnerabilities. Jan Stentoft and Ole Stegmann Mikkelsen guided us through the process exceptionally well.***
>
> - Hanne Korsholm, Supply Chain Manager, EXHAUSTO A/S



4
A Process Model with Four Phases

This chapter introduces the developed process model for enhancing Supply Chain Resilience in Danish manufacturing SMEs. The process model, illustrated in Figure 4.1, comprises four phases: 1) Map the supply chain, 2) Identify vulnerabilities and capabilities, 3) Prioritize and create cross-organizational alignment, and 4) Develop action plans. The person responsible for driving the process should start by watching the video where the process model is presented.

4.1 Phase 1: Map the Supply Chains

4.1.1 Introduction

Duration of activity: 3 hours.

Participants: Functions such as sales, production, procurement, product development, and finance/IT. In the digital solution, up to 10 people can participate, so the specific participation is determined by each company based on what is pragmatically feasible. However, cross-organizational representation is crucial.

Output: An overall mapping of the supply chains.

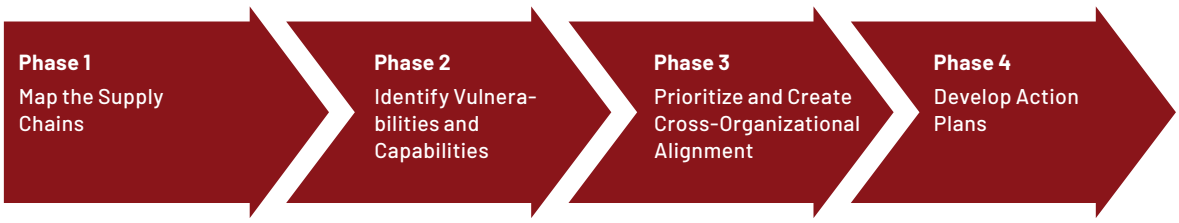
4.1.2 Procedure

The first phase aims to establish a shared understanding of the company's supply chains. Through our work with the 18 case companies, we have observed varying perceptions of the supply chains and the challenges faced by different departments. This process is often referred to as "Exchange of Ignorance."

The person responsible for the process should familiarize themselves with the 32 tools available at **www.scr-smv.dk**. Firstly, consider whether the process should be facilitated internally or with the assistance of an external facilitator (refer to tool 28 on facilitation). It is beneficial to prepare for the process by reviewing tools such as "PESTEL" (tool 2), "Supply Chain SWOT" (tool 3), "Mapping" (tool 4), "Supply Chain Complexity" (tool 5), "Customer Segmentation" (tool 6), "Material/Product Segmentation" (tool 7), "Supplier Categorization" (tool 8), and "It Takes Two to Tango" (tool 9). It may be advantageous for all participants to familiarize themselves with these tools.

Participants from different functions gather in a room where the company's supply chain can be visualized on a whiteboard or brown paper (see tool at **www.salesandoperationsplanning.dk**) that can be hung on a wall.

Figure 4.1: Process model for creating supply chain resilience



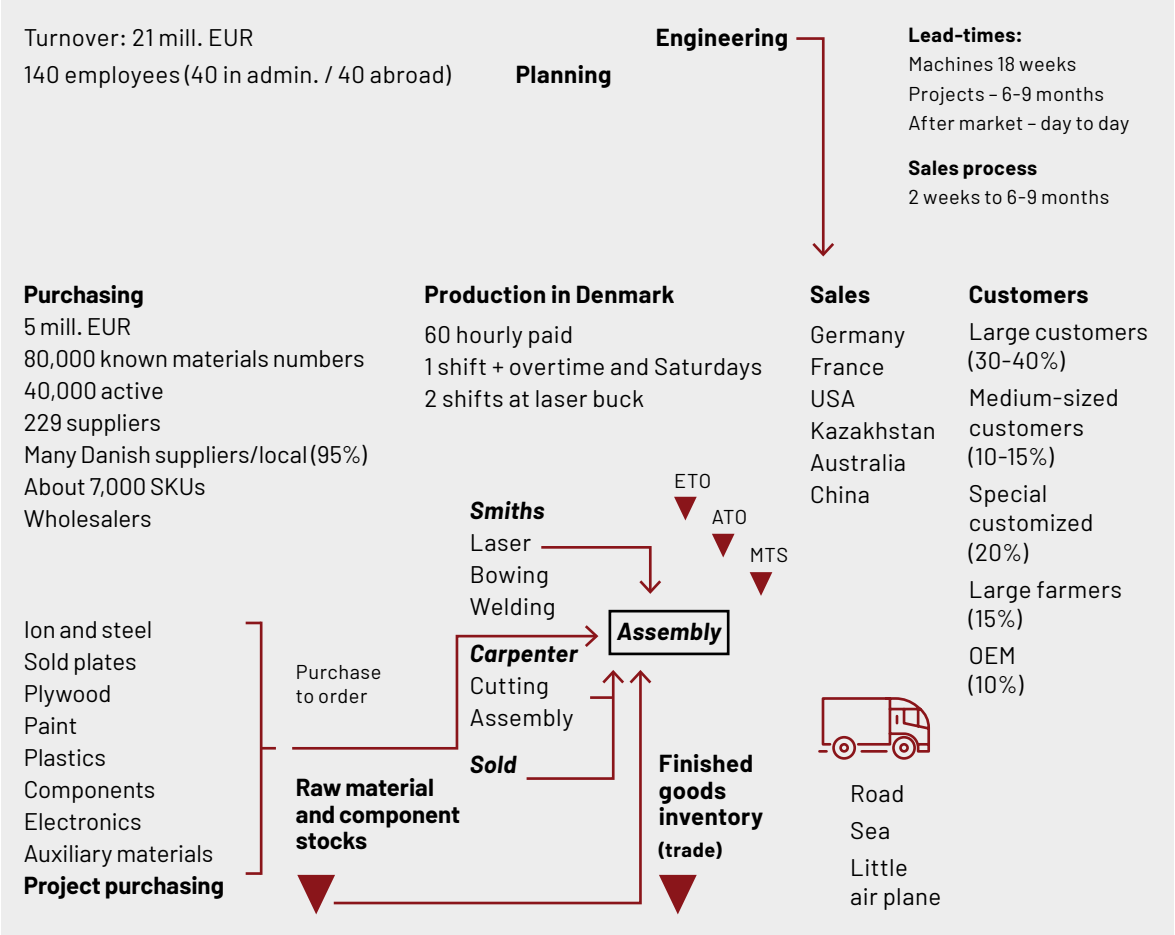
Participants should come prepared with facts based on tool 1: "Process for Day 1: Mapping - including fact questions." This tool includes specific questions that each function should prepare for before the meeting.

Start on the right side of the whiteboard/brown paper by illustrating customers and customer segments. Then, move to the left, mapping distribution channels, warehouses, and main production processes, ending with procurement on the far left. Information processes/flows are also depicted.

By the completion of Phase 1, the goal is to have a visualization of the company's supply chains, including customers, order intake, planning, production, and procurement. Additionally, include facts such as customer segments, revenue, distribution methods, storage points, number of suppliers, etc., along with the challenges experienced in the supply chains. It is important to avoid going into excessive detail during this exercise as the goal is to foster understanding, not drive immediate change.

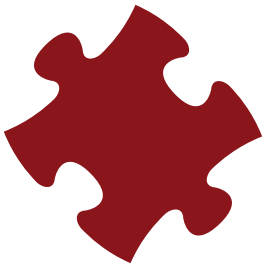
The day concludes by taking a picture of the mapped supply chain and the identified challenges. This contributes to establishing a common foundation for the subsequent phases of the process model. An example of an overall mapping is provided in Figure 4.2.

Figure 4.2: Example of an overall mapping




FARMDROID

FarmDroid ApS



(Data collected in late 2021/early 2022)

Located in Vejen, FarmDroid specializes in the development and manufacturing of self-driving field robots. These robots are the only fully automated ones capable of both seeding and mechanical weed control. Powered by high-precision GPS technology, the robots have the ability to track the location of every seed in the field during seeding. FarmDroid's mission is to help farmers and crop growers reduce costs for seeding and crop maintenance while operating in a CO2-neutral and organic manner through solar-powered robots. The company is primarily owned by founders Jens and Kristian Warming, with renowned robot pioneer Esben Østergaard as an investor. Established in the spring of 2018, the company has experienced substantial growth and currently employs nearly 40 office workers and 8 production and warehouse employees.

The production of FarmDroid robots takes place in their facilities in Vejen, where activities involve component assembly, configuration, and quality assurance. Steel and electronics used in the robots are sourced from both local and global subcontractors. The robots are distributed through a network of distributors, which currently covers a significant part of Europe and Canada. In 2022, over 95% of the robots were exported, and the company's strategy is focused on further global expansion, anticipating an increase in the export share.

During the COVID-19 pandemic, FarmDroid faced a surge in demand as travel restrictions in Europe resulted in a shortage of seasonal workers for fieldwork, who typically came from Eastern European countries. Additionally, the company encountered challenges related to component shortages from certain suppliers and transportation issues from the Far East. The closure of sales fairs also hindered relationship-building efforts.

Throughout the project, vulnerabilities were identified, including a lack of human resources and skills among both office workers and hourly employees, dependence on unique raw materials and suppliers, inventory management issues, and challenges in the procurement process and follow-up. To address these vulnerabilities, a set of capabilities were identified, emphasizing improved inventory management and data management, ABC classification and analysis, enhanced process documentation, flexible staffing arrangements, and cross-training to ensure multiple employees can perform various tasks.

> ***FarmDroid is a small growth company, and we highly value the importance of human resources and skills. The project has fostered a strong and aligned cross-functional focus within the company, making us aware of the significance of prioritizing scarce resources for tasks related to Supply Chain Resilience since our delivery capability serves as the foundation for future earnings.***
>
> - René Jannick Jørgensen, CEO, FarmDroid ApS.

4.2 Phase 2: Identify Vulnerabilities and Capabilities

4.2.1 Introduction

Duration of activity: 1-1.5 hours.

Participants: Participants from functional areas who individually work with the tool in their respective Excel files.

Output: Assessment of vulnerabilities and capabilities per functional area.

A zip file should be downloaded from the following address on scr-smv.dk:
https://scr-smv.dk/da/virksomheder/procesmodellen-i-praksis/

The zip file contains 12 Excel files in a folder. Save this folder on a shared drive accessible to all participants in the company. The files are free of macros and Visual Basic for Applications (VBA) coding, ensuring no security issues. For a starting point, use files Reg 01 to Reg 05 if there are five participants representing functions such as purchasing, production, sales, product development, and finance/IT. Companies can decide which functions should work with which files. If there are additional functions beyond these five, use Reg 06 and onwards. The file 'Reg Fælles' will be used in the project's third phase. The file 'Reg A' allows for subsequent viewing of various analyses based on the functions' responses, which will also be used in Phase 3.

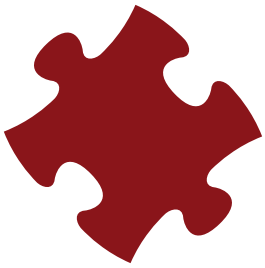
4.2.2 Procedure

In Phase 2, employees from different functional areas, such as sales, production, purchasing, finance/IT, and product development, will individually assess vulnerabilities and capabilities.

Before starting, it is recommended that participants watch two instructional videos available on **scr-smv.dk**:

Video about the process model:
https://scr-smv.dk/wp-content/uploads/2023/04/Gennemgang-af-procesmodel.mp4

> ***I have had an eye-opening experience collaborating with the researchers from SDU. It has made me realize how much our management team has been focused on resolving daily issues without finding the time to think about long-term strategies. However, these two researchers have provided us with research that is practical, relevant and that works. They brought us together and guided us through risk management and crisis preparedness, which I am confident will bring benefits to Linatech.***
>
> - Lars Rahbæk, CEO and co-owner, Linatech A/S quoted in Kristensen (2023)



Video about the selection and prioritization of vulnerabilities and capabilities:
https://scr-smv.dk/wp-content/uploads/2023/04/Saadan-bruges-softwaret.mp4

Each participant should download the following tools from the project website (**www.scr-smv.dk**):

- 10. Process for Day 2: Vulnerabilities and Capabilities
- 11. Gross list of Vulnerabilities (75 pre-defined)
- 12. Gross list of Capabilities (97 pre-defined)

Detailed definitions of vulnerabilities and capabilities are intentionally not provided, as it is up to the employees to define the content in an internal language relevant to the company. These assessments are subjective and not exact science. There is also an opportunity to write notes on the selection of vulnerabilities and capabilities.

Multiple individuals from each functional area can contribute to filling out the Excel file, but only one file should be filled out per functional area. Within the file, each functional area should prioritize up to 10 vulnerabilities in the company's supply chains from the perspective of the function. Then, assess up to five capabilities that are most necessary to address these vulnerabilities. The work is based on the mapping from Phase 1. Once the file is completed, save it with the same file name and in the same folder on the shared drive as the other files. This is important for further work with the model.

4.3 Phase 3: Prioritize and Create Cross-Organizational Alignment

4.3.1 Introduction

Duration of activity: 3 hours.

Output: Consolidated prioritization of vulnerabilities and capabilities.

Participants familiarize themselves with Tool 14 "Process for Day 3: Prioritize and Create Cross-Organizational Alignment".

4.3.2 Procedure

Based on the individual assessments of vulnerabilities and capabilities in Phase 2, a comprehensive overview is now created to understand how functions in the companies have responded. Pragmatically, participants can review the top 10 vulnerabilities and analyze the agreement or disagreement regarding the perceived vulnerabilities, the necessity of associated capabilities, and their current level. "Reg A" can be used to create a collective overview of each function's input, allowing for automatic prioritization. First, the vulnerabilities are addressed, and each participant presents their work. Then, the collective material is discussed with the aim of reaching a consolidated list of a maximum of 10 vulnerabilities. Subsequently, the entire group discusses the necessary

capabilities to address the vulnerabilities and determines the importance and current level of development for each capability within the company. To maintain the work, record the results in the "Reg Fælles" file. "Reg Fælles" serves as the basis for prioritization in Phase 4 regarding action plans. For capabilities considered highly important, where there is a gap between the current and desired level, concrete action plans should be developed to close the gap. For example, if the capability "K5.3 More suppliers/supply sources" is identified as crucial, but there are no resources working strategically with sourcing, it may be necessary to strengthen the procurement department with a resource focused on strategic thinking. This prioritization will take place in Phase 4. The third phase aims to ensure cross-functional alignment and prioritization. Working on vulnerabilities and capabilities is a process that contributes to a greater mutual understanding of the company's vulnerabilities and provides concrete solutions to enhance resilience. Specific examples of prioritizations of vulnerabilities and capabilities are shown in Table 4.1 and 4.2.

In Table 4.2, the assessment of the company's current level of ability for each capability is presented, using a scale of 1 to 5, where 1 indicates a very low level and 5 indicates a very high level. Similarly, the importance of each capability is indicated using a scale of 1 to 5, where 1 represents very unimportant and 5 represents very important.

Table 4.1: Example of collective prioritization of vulnerabilities

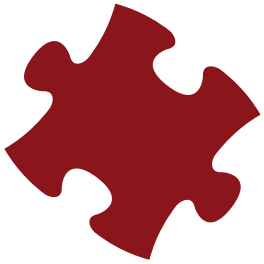
Priority	Vulnerability	Note
1	V3.2 Reliability of equipment	Laser
2	V3.1 Too low production capacity	Moving bottlenecks
3	V5.3 Too low supplier reliability	When manufacturing lacks goods
4	V3.7 Lack of human resources	Should be viewed together with "V3.8 Lack of competencies"
5	V3.12 Lack of financial resources	Capital tied up in inventories, stagnant inventory, payment terms with suppliers, postponed maintenance improvements
6	V4.4 Too low data quality	Drawings and specifications of goods; old basis of drawings; much tacit knowledge
7	V5.2 Lack of accessibility of raw materials and supplies	Steel
8	V3.11 Too dependent on key persons	Especially blacksmiths (should be considered in relation to tacit knowledge
9	V3.6 Lack of cross-functional collaboration (silo-culture)	Departments are fragmented – When one is under pressure, they close in on themselves
10	None	

Table 4.2: Example of collective prioritization of capabilities in relation to Table 4.1

Vulnerability	Capabilities	Current level	Importance
V3.2 Reliability of equipment's	C3.15 Systematic maintenance	2	4
V3.1 Too low production capacity	C3.8 Capability to prevent errors	2	5
	C3.10 Productivity/elimination of waste	2	5
	C3.6 Manufacturing foundation	3	5
	C7.3 Execution skills	2	5
	C3.16 Standardized workflows/processes	2	5
V5.3 Too low supplier reliability	C5.3 Increased suppliers/sources of supply	3	4
	C5.5 Prioritization (segmentation) of suppliers	1	5
	C5.7 Supplier development	2	5
V3.7 Lack of human resources	C7.8 Capability to attract new employees	3	5
	C7.7 Access to qualified labor	3	4
V3.12 Lack of financial resources	C3.18 Continuous improvement	2	5
	C3.15 Systematic maintenance	2	5
	C1.6 Cash flow	3	5
	C4.4 Min/max inventory management	2	5

Among the 10 case companies that participated in the testing phase of the process model, a total of 31 out of the 75 predefined vulnerabilities listed in Tool 11, "List of Vulnerabilities," were included in the jointly decided vulnerabilities during phase 3. These 31 vulnerabilities are illustrated in Figure 4.3. Notably, "Lack of cross-functional collaboration (silos)" and "Unpredictable demand" were consistently prioritized vulnerabilities in eight of the companies. This indicates that small and medium-sized enterprises (SMEs) also encounter challenges related to siloed organizational structures.

"Lack of availability of raw materials and supplies (specialized)" and "Too dependent on key persons" were among the prioritized vulnerabilities in six companies. Conversely, it was observed that 12 vulnerabilities were only prioritized by one company. This outcome demonstrates that there are vulnerabilities common to the participating companies, as well as vulnerabilities specific to each company's unique circumstances. Among the 18 case



companies, it was noted that growth can trigger vulnerabilities, which may explain why vulnerability "V6.3 Too high/low growth" was not included in the final prioritized lists for any of the companies."

In phase 3, the employees in the test phase with the 10 companies have collaboratively prioritized the capabilities they deem important for addressing the identified vulnerabilities.

Figure 4.4 illustrates the capabilities included in these prioritizations and the number of companies that have included them. As depicted in Figure 4.4, 66 out of the 97 predefined capabilities from Tool 12: "List of Capabilities" have been utilized. Specifically, the capabilities of "Internal information exchange - internal" and "Increased suppliers/sources of supply" have been recognized as crucial for enhancement in nine companies.

The emphasis on internal information exchange aligns with the identified vulnerability of silo formation. Furthermore, it is worth noting that 14 capabilities have been exclusively identified by a single company, highlighting the diverse needs in addressing different vulnerabilities.

4.4 Phase 4: Develop Action Plans

4.4.1 Introduction

Duration of activity: 3 hours.

Output: Joint action plans for focus areas including what, why, when, who, etc.

Participants should familiarize themselves with Tool 19: 'Action Plans'.

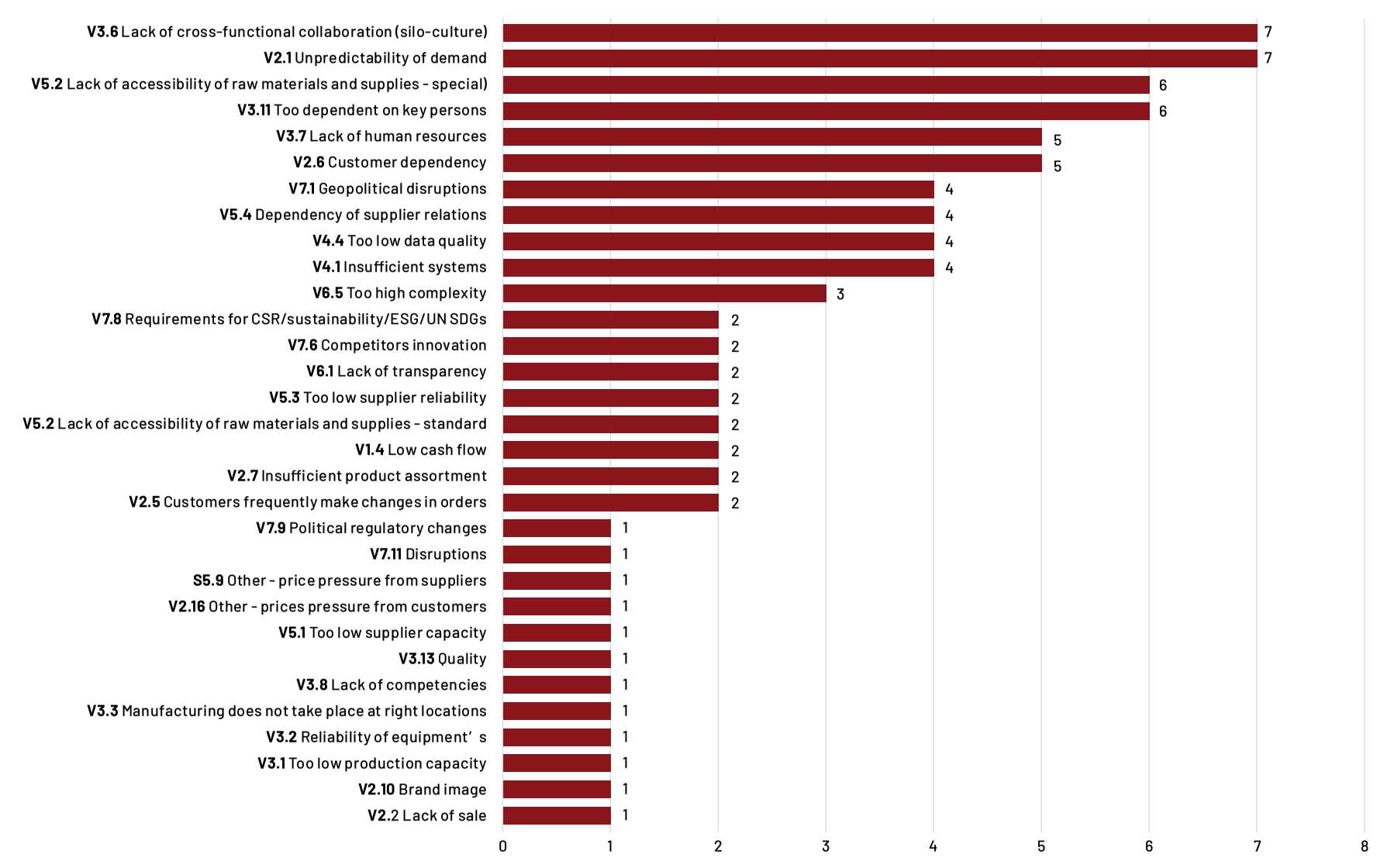
4.4.2 Procedure

The functional areas involved come together in a collaborative meeting to formulate specific action plans aimed at enhancing the identified and prioritized capabilities that can effectively address the vulnerabilities identified. An illustrative example of an action plan is presented in Table 4.3.

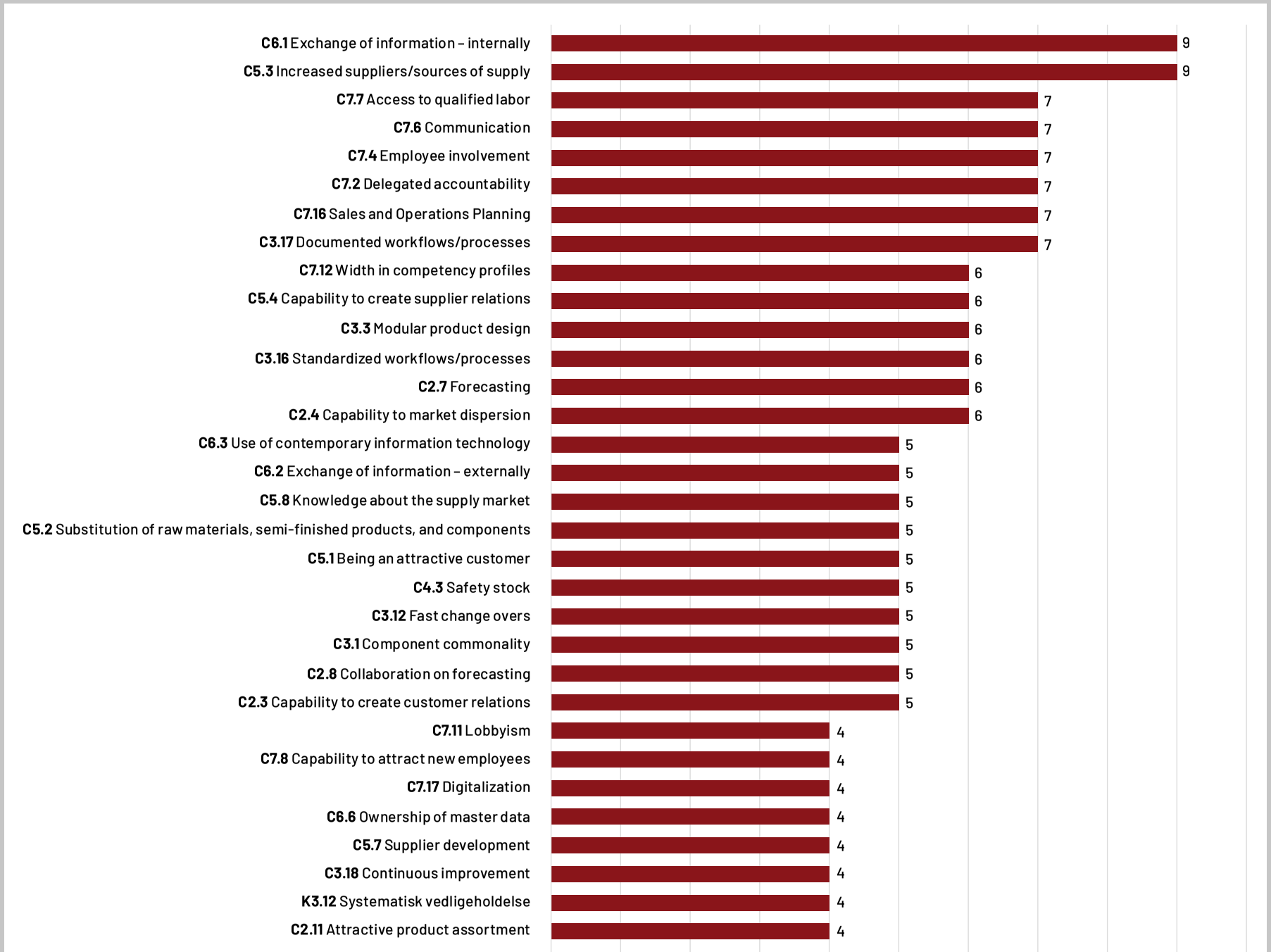
Table 4.3: Example of an action plan

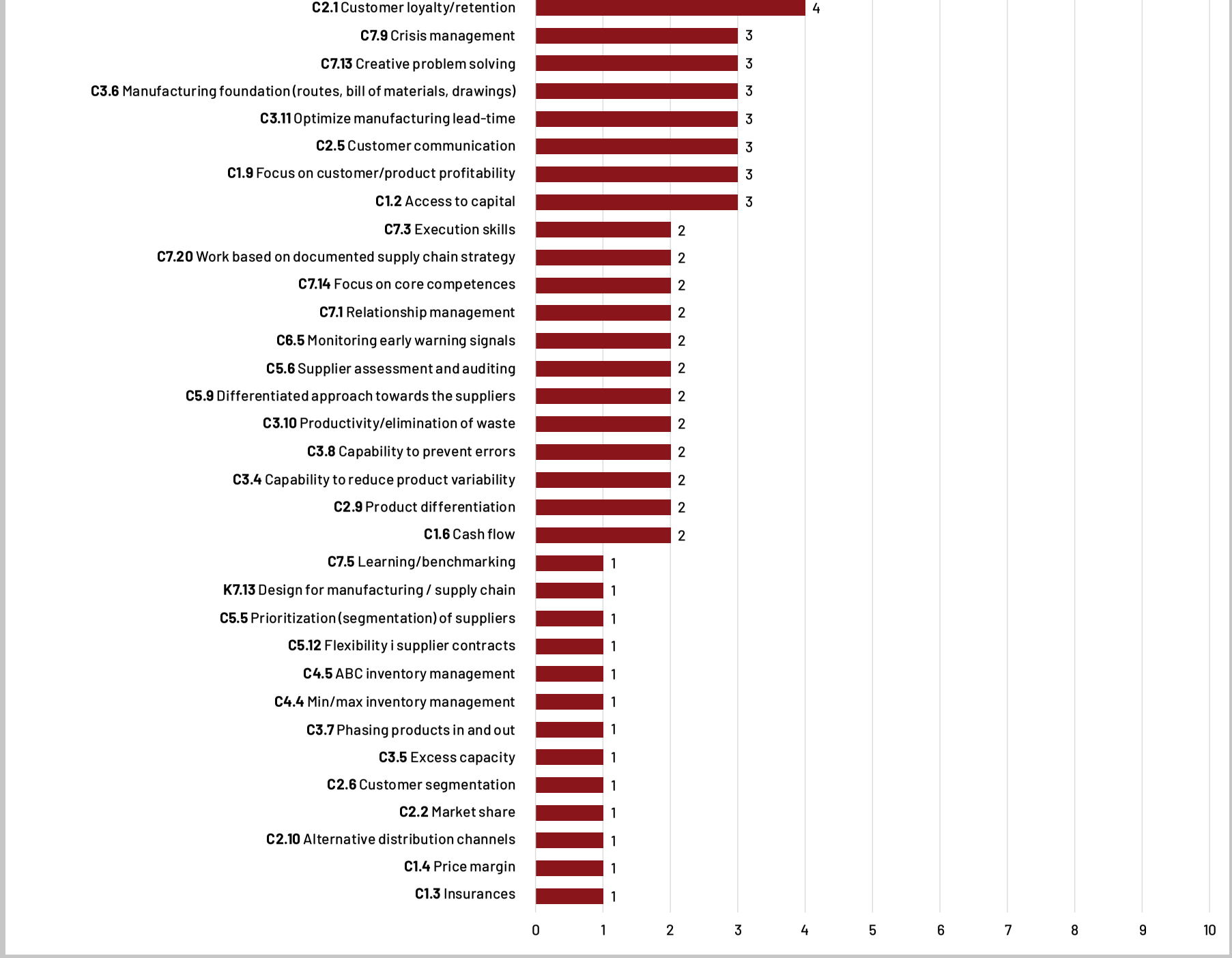
Improvement area	Description	Objective	Responsible	Deadline
Too low production capacity	Bottlenecks in process areas Lack of qualified labor force (job centers + multiple shifts)	Increase capacity with x%	JS	xx.xx.xx
Reliability of equipment	Maintenance plan Training of employees	Increase output at critical resources	OSM	xx.xx.xx
Too low supplier reliability	Improve forecast Strengthen relationship management and communication	Improve the ability to deliver	TK	xx.xx.xx

Figure 4.3: Prioritized vulnerabilities collectively among the companies in the second phase



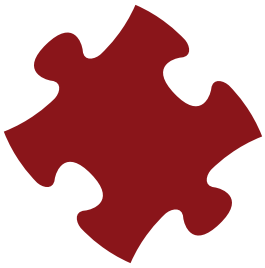
Figur 4.4: Prioritized capabilities collectively among the companies in the second phase




C2.1 Customer loyalty/retention 4
C7.9 Crisis management 3
C7.13 Creative problem solving 3
C3.6 Manufacturing foundation (routes, bill of materials, drawings) 3
C3.11 Optimize manufacturing lead-time 3
C2.5 Customer communication 3
C1.9 Focus on customer/product profitability 3
C1.2 Access to capital 3
C7.3 Execution skills 2
C7.20 Work based on documented supply chain strategy 2
C7.14 Focus on core competences 2
C7.1 Relationship management 2
C6.5 Monitoring early warning signals 2
C5.6 Supplier assessment and auditing 2
C5.9 Differentiated approach towards the suppliers 2
C3.10 Productivity/elimination of waste 2
C3.8 Capability to prevent errors 2
C3.4 Capability to reduce product variability 2
C2.9 Product differentiation 2
C1.6 Cash flow 2
C7.5 Learning/benchmarking 1
K7.13 Design for manufacturing / supply chain 1
C5.5 Prioritization (segmentation) of suppliers 1
C5.12 Flexibility i supplier contracts 1
C4.5 ABC inventory management 1
C4.4 Min/max inventory management 1
C3.7 Phasing products in and out 1
C3.5 Excess capacity 1
C2.6 Customer segmentation 1
C2.2 Market share 1
C2.10 Alternative distribution channels 1
C1.4 Price margin 1
C1.3 Insurances 1
0 1 2 3 4 5 6 7 8 9 10

Fredericia

Fredericia Furniture A/S



(Data collected during autumn 2022)

Fredericia Furniture, a family-owned company established in 1911, holds a rich heritage in Scandinavian furniture design and production. Many of their furniture pieces have achieved global recognition as timeless classics, with a significant portion of their collections continuously produced for decades.

Starting as Fredericia Stolefabrik (Fredericia Chair Factory), the company has consistently built upon its furniture expertise and craftsmanship, which it refers to as design. At Fredericia Furniture, original furniture pieces are meticulously created, incorporating distinct features such as form, size, construction, surface treatment, materials, and exceptional craftsmanship. These elements collectively contribute to the uniqueness of Fredericia Furniture's creations.

Throughout the project, various vulnerabilities were identified, including unpredictable demand, excessive complexity, reliance on key employees, supplier dependency, limited human resources, and inadequate systems. To address these vulnerabilities, several capabilities were recognized as areas for further development and focus. These include enhancing customer service workflows for inquiries, implementing Sales & Operations Planning, standardizing and streamlining workflows, segmenting suppliers, documenting workflows, facilitating cross-training among employees, and ensuring efficient management of master data.

Our participation in the Supply Chain Resilience project sparked valuable discussions across our sales, product development, sustainability, procurement, production, and finance functions. The process shed light on areas where intervention and the strengthening of capabilities are necessary to manage vulnerabilities effectively. Allocating time to delve into our supply chains with broad organizational representation has proven to be highly beneficial.

- Michael Borch, COO, Fredericia Furniture A/S

KVM Conheat Genvex

KVM-Genvex A/S

Data collected in late 2021/early 2022)

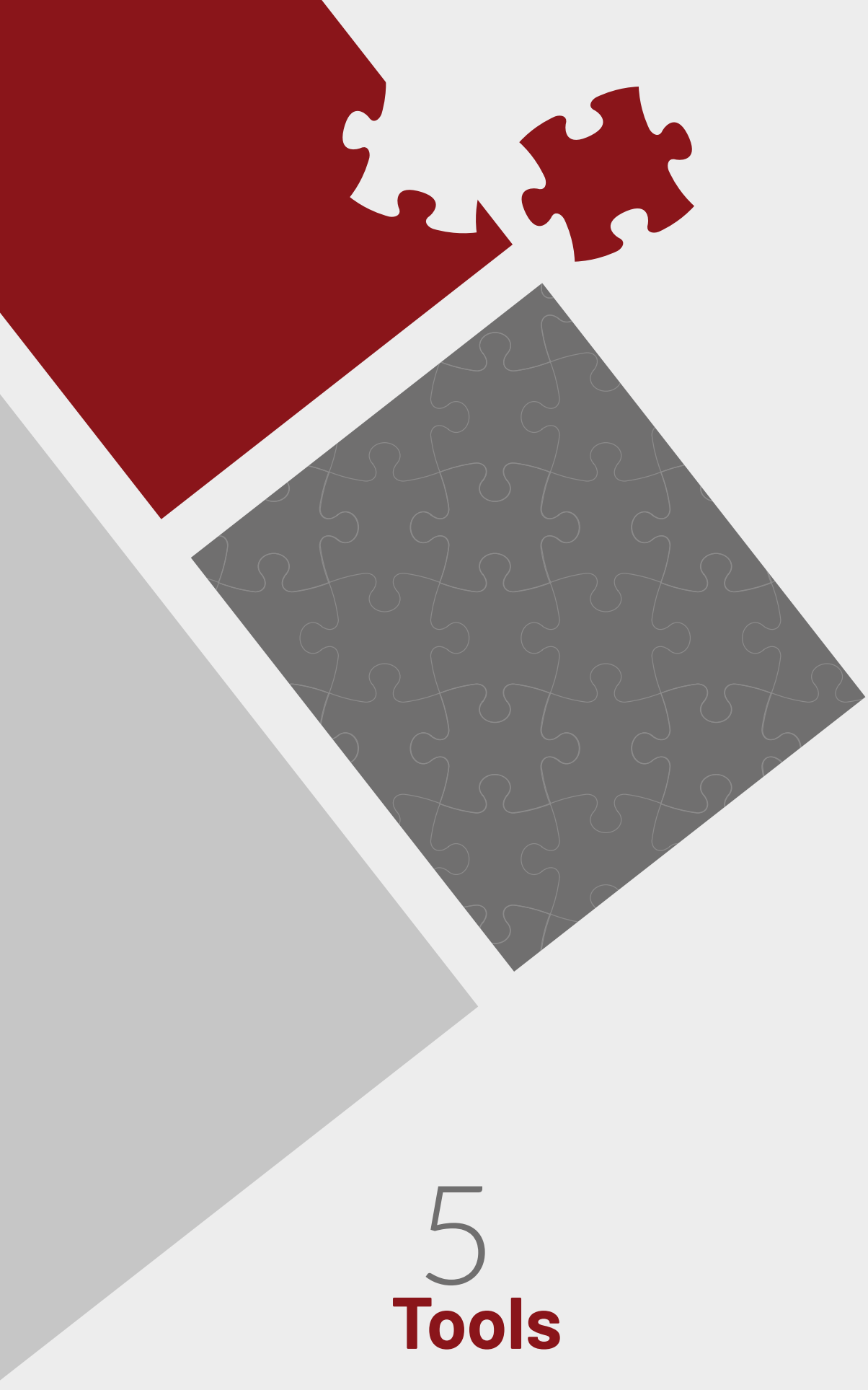
KVM-Genvex is a Danish company headquartered in Haderslev, located in Southern Jutland. The company operates as part of the NIBE Industries group. In Haderslev, the KVM division specializes in producing district heating solutions, while Genvex focuses on manufacturing ventilation systems. Both KVM and Genvex primarily cater to the residential sector, providing products for single-family homes and apartments. Additionally, KVM offers district heating solutions for commercial construction projects of various scales. While KVM-Genvex predominantly serves the Danish market, it also exports to a majority of European countries. Notably, Germany is a significant market for ventilation products, and Genvex acts as an OEM supplier of Nibe ventilation products in Germany. In the district heating sector, major export destinations include Germany, the Netherlands, and England. The company sources 80-90 percent of its raw materials from European suppliers.

KVM-Genvex is a subsidiary of METRO THERM, which is itself part of the Swedish conglomerate NIBE Group. Established in 1999, KVM-Genvex employed 88 individuals as of the end of 2020.

During the COVID-19 outbreak, KVM-Genvex experienced increased demand from the construction industry. However, they also encountered challenges such as extended lead times, uncertainty surrounding deliveries, and allocation issues from suppliers. In some cases, they received only 10 percent of the ordered quantity for certain product groups. These difficulties affected production schedules and had significant implications for sales and external deliveries.,

Participation in the project revealed various vulnerabilities, including ERP system complexity, cybersecurity concerns, raw material and component availability, and human resources. To address these vulnerabilities, KVM-Genvex implemented several initiatives, such as enhancing visibility of employees and equipment, promoting employee involvement, utilizing common components, and increasing modularization.

> ***The project has facilitated collaboration across our organization. We recognize that we face the same problems and challenges, but we approach them differently and handle them on a day-to-day basis in different ways. It has been truly enlightening to gain insights from perspectives beyond procurement and production. Through this process, we have acquired valuable tools to improve communication throughout the organization and have tangible resources to guide our efforts instead of relying solely on urgent demands or questioning our delivery capabilities.***
>
> - Jonas Andreasen, Production Manager, KVM-Genvex A/S



5
Tools

Throughout the development of the process model, valuable input from participants in the 18 case companies has led to the identification of additional tools to support the overall process. A total of 32 tools have been developed, some of which are specific to certain phases, while others can be utilized throughout the entire process.

Each tool is introduced with the following details:

1. Purpose

2. Participants

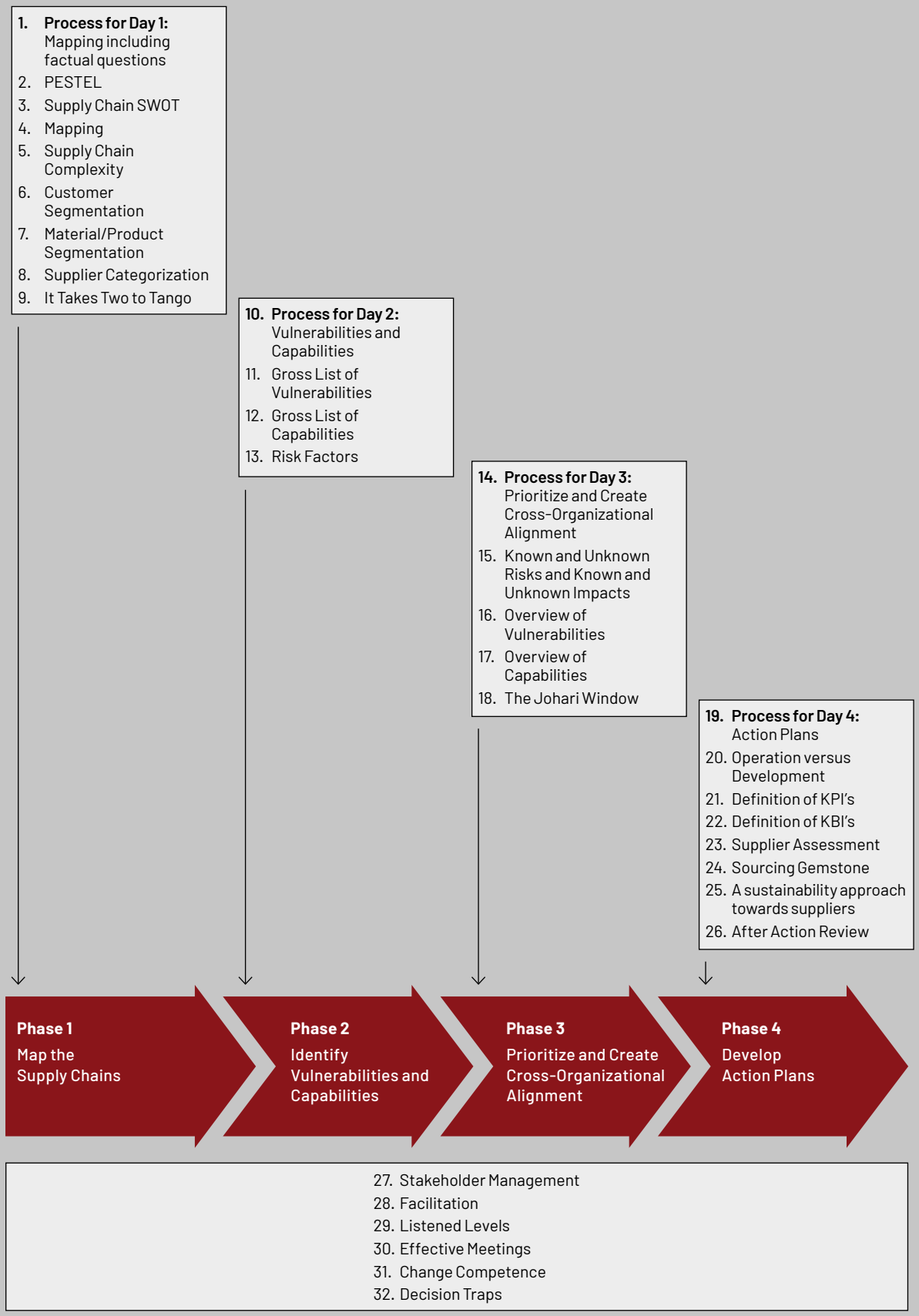
3. Application.

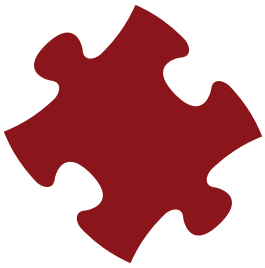
These tools are intended to serve as inspiration, and it is not mandatory to utilize all of them. A comprehensive overview of the 32 tools is presented in Figure 5.1. They can be accessed on the project's website (**www.scr-smv.dk**) by selecting the "Tools" menu.

5.1 Tools for Phase 1

Nine tools are recommended for Phase 1, as depicted in Figure 5.1 and Table 5.1. The initial tool, "Process for Day 1: Mapping - including factual questions," outlines the objectives of Phase 1 and provides a set of questions that participants can prepare in order to facilitate a fact-based mapping process. It is important to note that the mapping exercise should not delve into excessive detail. The main goal is to establish a shared understanding of the company's supply chains and the associated challenges.

Figure 5.1: The process model and 32 tools





Throughout the project with the 18 companies, the mapping exercise has proven to be enlightening, often resulting in "aha" moments. The demanding nature of daily routines often discourages individuals from dedicating time to collaborate across functions and develop a collective comprehension of supply chains.

Concrete mapping activities have highlighted vulnerabilities stemming from companies heavily relying on single-source suppliers for raw materials and semi-finished goods. Moreover, there has been a notable lack of consensus regarding forecasting accuracy and an underestimation of the extent of tacit knowledge within organizations.

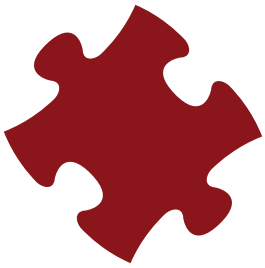
The primary outcome of this process is the comprehensive mapping itself, along with the discussions and insights generated throughout the exercise. In addition to the "Process for Day 1" and the mapping tool, eight supplementary tools are suggested to inspire and support the mapping meeting (refer to Table 5.1).

Table 5.1: Tools for phase 1

Name of Tool	Phase	Purpose/Contribution
1. Process for Day 1: Mapping including factual questions	1	To map the company's supply chains including specific facts.
2. PESTEL	1	To analyze macroeconomic factors that influence the company.
3. Supply Chain SWOT	1	To create an overview and information to match the company's strengths and weaknesses in the supply chains with the opportunities and threats in the environment.
4. Mapping	1	To establish a common understanding of how the company's supply chains are structured (customers, segments, demand patterns, distribution channels, inventories, production methods, data quality, ERP system, employees, suppliers, volumes, quantities, etc.).
5. Supply Chain Complexity	1	To focus on the complexity of the company's supply chains and identify the drivers of complexity. Supply chain complexity is a result of both internal and external factors.
6. Customer Segmentation	1	To identify customer segments and support a dialogue on differentiated management and customer strategies, with a main focus on key customers.
7. Material/Product Segmentation	1	To facilitate a common understanding of which materials and products are strategically important and which ones are standard.
8. Supplier Categorization	1	To assess which suppliers are most valuable to the company and therefore require special focus in terms of relationship management initiatives.
9. It Takes Two to Tango	1	To identify strategies based on product segmentation and the supplier's perception of the company as a customer.


LINATECH

Linatech A/S



(Data collected in the autumn of 2022)

Linatech has its roots in old blacksmith traditions dating back to 1884 and is now a modern and successful company that delivers high-quality machines, process plants, and components. With a workforce of 50 employees spread across its Vium and Thorning departments, Linatech operates in a total area of 7,500 square meters encompassing production facilities, warehouses, and administrative buildings.

The company serves clients in various sectors, including wind energy, industrial applications, medical, transportation, food processing, district heating, environmental, and recycling. Linatech prides itself on nurturing long-term relationships built on trust with its customers. The company's diverse competencies span multiple business areas, including development projects, customized machinery, subcontracting, automation, assembly, and service. During the COVID-19 crisis, Linatech encountered challenges related to a shortage of electrical components and significant delivery delays.

Participation in the project allowed Linatech to identify several vulnerabilities, such as limited availability of raw materials and supplies, reliance on key personnel, silo mentality within the organization, and inadequate human resources. In response, Linatech focused on implementing a range of development initiatives, including finding alternative suppliers and gaining deeper insights into the supply market, optimizing, and simplifying products, enhancing internal communication, standardizing workflows, and increasing resources. During a presentation of Linatech's participation in the project at SDU on December 8, 2022, CEO Lars Rahbæk mentioned that he had been tagged on LinkedIn about the opportunity to participate in the project. Initially, the management team perceived the supply chain challenges to be primarily related to the purchasing department.

The management team consists of the CEO, sales manager, finance manager, and development manager. Purchasing was not represented in the management team. After going through the process model with the involvement of the procurement responsible, initiatives in the purchasing area dropped to the seventh priority. The project provided a platform for participants to engage in discussions regarding development needs and align their efforts.

> ***For Linatech A/S, participating in the Supply Chain Resilience project has revealed that we needed more than just a quick fix in purchasing. It has highlighted the need for action across the entire delivery process. We have realized that our dependency on a few customers and suppliers is too significant, and we must enhance our resilience to navigate major global events such as pandemics, wars, and disruptions in volatile supply chains.***
>
> - Lars Rahbæk, CEO and co-owner, Linatech A/S

5.2 Tools for Phase 2

For Phase 2, we have developed four tools, as outlined in Table 5.2. Tool 10, "Process for Day 2: Vulnerabilities and Capabilities", provides guidance on the individual assessment of critical vulnerabilities and the necessary capabilities for addressing them within the company. Additionally, we have included tools that provide comprehensive lists of vulnerabilities and capabilities. We recommend printing these lists before utilizing the digital tool. Using a highlighter to mark a maximum of 10 vulnerabilities and up to five capabilities per vulnerability can facilitate data entry in the digital tool. Furthermore, Tool 13 presents a list of 41 risk factors that can serve as inspiration and be evaluated for their relevance in the specific context. As indicated in Table 5.2, Tools 11, 12, and 13 are applicable in both Phase 2 and Phase 3.

5.3 Tools for Phase 3

For Phase 3, we have identified five tools that are listed in Table 5.3. Tool 14, "Process for Day 3: Prioritize and Create Cross-Organizational Alignment," provides a step-by-step description of the collaborative process to foster a shared understanding of vulnerabilities and necessary capabilities. In this phase, there are also two tools that guide the utilization of the Excel file "Reg A" from the comprehensive zip file. These tools explain how to create an overview of participants' responses regarding vulnerabilities and capabilities using pivot tables. Videos available on www.scr-smv.dk further elaborate on this process. Additionally, two tools address known and unknown risks, as well as the Johari Window, which can enhance communication within the team.

Table 5.2: Tools for phase 2

Name of Tool	Phase	Purpose/Contribution
10. Process for Day 2: Vulnerabilities and Capabilities	2	To evaluate which vulnerabilities the participants believe the company's supply chains are most exposed to and hereafter identify the capabilities necessary to address those vulnerabilities.
11. Gross List of Vulnerabilities	2/3	To assist participants in identifying a maximum of 10 vulnerabilities they believe the company is most exposed to.
12. Gross List of Capabilities	2/3	To assist participants in identifying a maximum of 5 capabilities for each vulnerability that they believe can help address the vulnerabilities.
13. Risk Factors	2/3	To explore different types of risks that can create vulnerabilities in the supply chains.

Table 5.3: Tools for phase 3

Name of Tool	Phase	Purpose/Contribution
14. Process for Day 3: Prioritize and Create Cross-Functional Alignment	3	To evaluate which vulnerabilities are collectively believed to pose the greatest risk to the company's supply chains and then identify the necessary capabilities to manage those vulnerabilities.
15. Known and Unknown Risks and Known and Unknown Impacts	3	To create a shared overview of known and unknown risks, as well as their impact.
16. Overview of Vulnerabilities	3	To develop a functional overview and a comprehensive company overview of vulnerabilities based on individual reports.
17. Overview of Capabilities	3	To develop a functional overview and a comprehensive company overview of capabilities based on individual reports.
18. The Johari Window	3	To improve communication, teamwork, feedback, and conflict management (increase self-awareness)

5.4 Tools for Phase 4

In Phase 4, we propose eight tools to support the development of action plans, as outlined in Table 5.4. The starting point for this phase is Tool 19, which describes the process of developing action plans. When selecting specific focus areas, it is crucial to consider activities that yield tangible results, such as increased sales, cost reductions, quality improvements, and shorter lead times. In other words, prioritize initiatives that contribute to revenue growth and improve the bottom line. Engaging an external partner can be beneficial to challenge the focus areas and avoid internal biases.

Following Tool 19, we provide seven tools that address managing development in a busy operational environment and defining Key Performance Indicators (KPIs) and Key Behavioral Indicators (KBIs). It is important to establish KPIs that align with development goals and monitor them regularly. We also offer tools to inspire supplier evaluations and sourcing strategies. As sustainability becomes increasingly important in supply chains, we have included a tool to support clarification and alignment with suppliers who may have varying motivations regarding sustainability. Lastly, a tool for conducting an After Action Review is included to facilitate learning from handling supply chain challenges. It prompts critical questions such as what to continue doing, what to stop doing, and what to start doing.

Table 5.4: Tools for phase 4

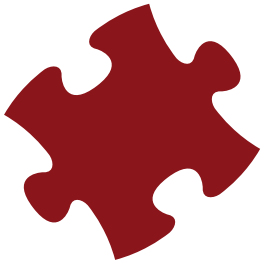
Name of Tool	Phase	Purpose/Contribution
19. Process for Day 4: Develop Action Plans	4	To develop concrete action plans to eliminate or reduce the prioritized vulnerabilities.
20. Operation versus Development	4	To provide ideas and guidance on how to prioritize development activities in a busy operational environment.
21. Defining Performance Indicators (KPI's)	4	To establish a set of KPIs that visualize the desired effects of the Supply Chain Resilience efforts.
22. Defining Key Behavioral Indicators (KBI's)	4	To create a process for addressing the expected behavior in the company in general and in projects (specifically Supply Chain Resilience).
23. Supplier Assessment	4	To evaluate suppliers in the sourcing process.
24. Sourcing Gemstone	4	To assess which sourcing strategies should be applied to suppliers.
25. A Sustainability Approach Towards Suppliers	4	To evaluate which suppliers are motivated to work on sustainability and which ones are less motivated.
26. After Action Review	4	To identify incidents/practices that can provide learning opportunities.

> ***A key takeaway from the process is that we now have monthly meetings across all functions to discuss supply chain issues, particularly supply challenges. This has created a shared understanding and a common language for addressing our reality. We are actively working on standardizing processes, and the Supply Chain Resilience project has brought to light process gaps. Lastly, it has clarified roles and responsibilities within our organization.***
>
> - Bende Egebro Daugaard, COO, Airco Process Technology
> quoted in Breil-Hansen (2023).

Upon completing Phase 4, the company will have a concrete action plan that outlines activities to mitigate identified vulnerabilities. However, implementing the plan can be more challenging than creating it. To enhance the ability to manage development challenges within a busy operational environment for SMEs, we offer the following recommendations:

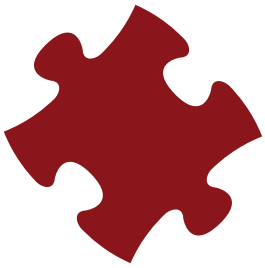
- Form a cross-organizational group dedicated to Supply Chain Resilience (the team from the process model can be utilized).
- Schedule regular meetings (e.g., bi-weekly or monthly) and prioritize their continuity.
- Prepare specific meeting agendas and document in meeting minutes.
- Assign responsibility for implementing identified activities and set clear deadlines.
- Seek top management support by providing regular reports on the progress of the work.
- Allocate project work to half-day sessions, allowing time for operational tasks to be accomplished.

Following these recommendations can help foster a dedicated Supply Chain Resilience and risk management culture.



Logitrans
lifting performance

Logitrans A/S



(Data collected in late 2021/early 2022)

Logitrans is a privately-owned company headquartered in Ribe, Denmark. Established in 1940, the company specializes in the manufacturing and sale of ergonomic internal material handling equipment, including pallet trucks, high lifters, stackers, rotators, tilters, and custom solutions. Logitrans serves core industries such as printing and packaging, food, pharmaceuticals, and the component industry. Their product range includes both painted and stainless steel options. With over 150 skilled employees, Logitrans possesses extensive expertise in development, production, sales, and service, enabling them to meet customers' requirements worldwide.

They have manufacturing facilities in Denmark and China (Ningbo), with order-based production in Denmark and forecast-driven production in China. The company also maintains a representative office in Germany and a subsidiary in the USA. Approximately 95% of their production is exported to over 55 countries, with sales conducted through distributors. Standard products constitute 85% of their offerings, while the remaining 15% are custom-made solutions. Logitrans collaborates with around 100 suppliers, with a significant portion supplying to the Ningbo factory.

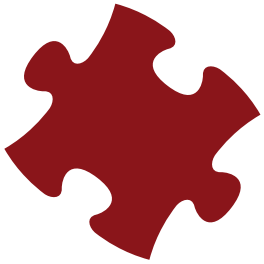
Logitrans has long been recognized as a global leader in internal material handling equipment, focusing on quality and environmental consciousness to meet future requirements. Additionally, the company participates in several projects with sustainability as the central theme.

During the COVID-19 pandemic, Logitrans encountered various challenges, including difficulties in obtaining goods from China. They faced long lead times, high transportation costs, lack of transparency in supply chain visibility, and price increases in components, impacting their supply, production, and sales operations. Challenges in importing from China also affected the delivery capabilities of their Danish factory.

As a result of participating in the resilience process, Logitrans identified vulnerabilities such as a shortage of skilled labor, dependency on unique raw materials and suppliers, unpredictable demand, cybersecurity risks, and political and regulatory changes. To address these vulnerabilities, Logitrans implemented focused initiatives, including new employee recruitment, cross-training programs, optimized inventory management, increased dual sourcing, and improved forecasting capabilities.

> ***Through this project, we have gained a clearer understanding of the vulnerabilities in our supply chains and have developed a specific and prioritized list of initiatives to enhance our resilience to disruptions.***

- Rasmus Otzen, Supply Chain Manager, Logitrans A/S



5.5 General Tools

Table 5.5 comprises six general tools that are applicable and beneficial across all phases. The first tool is the stakeholder analysis, a classic practice mentioned in project management books as crucial but often overlooked or forgotten. This tool helps identify important inputs for the process and potential resistance in specific development areas.

Another tool included is facilitation, which focuses on the decision between using an internal resource or engaging an external advisor to facilitate the process. Hence, tool 28 describes the advantages and disadvantages of each option. However, we strongly recommend considering an external advisor to ensure progress in the activities since internal tasks tend to be continually postponed due to competing daily operations.

In addition, we have included process tools related to listening levels, conducting effective meetings, and change competence. These topics require increased attention and can greatly contribute to the success of the process. Lastly, tool 32 provides brief descriptions of nine decision traps to be mindful of and avoid.

Table 5.5: General tools for all phases

Name of Tool	Phase	Purpose/Contribution
27. Stakeholder Analysis	All	To gain an overview of internal and external stakeholders who are either part of the company or on which the company depends, and then plan their involvement.
28. Facilitation	All	To raise awareness of the need to ensure the right competencies to facilitate the process of creating Supply Chain Resilience.
29. Listened Levels	All	To focus on communication among participants and ensure a better understanding of others' perceptions and challenges.
30. Effective Meetings	All	To ensure that meetings are conducted efficiently, where purpose and goals are achieved with the appropriate resource utilization.
31. Change Competences	All	To assess employees' readiness for change through pragmatic questions.
32. Decision Traps	All	To ensure that important decisions are made based on the most accurate foundation possible.


Odder
EST. 1925

Odder Barnevogns-fabrik A/S

(Data collected in the autumn of 2022)

Odder Barnevognsfabrik, founded in 1925, is the last remaining pram factory in Denmark. With approximately 30 employees, the company specializes in producing high-quality and safe prams for families, childminders, and institutions across the country. Their focus lies on ensuring product safety, quality, comfort, and appealing design.

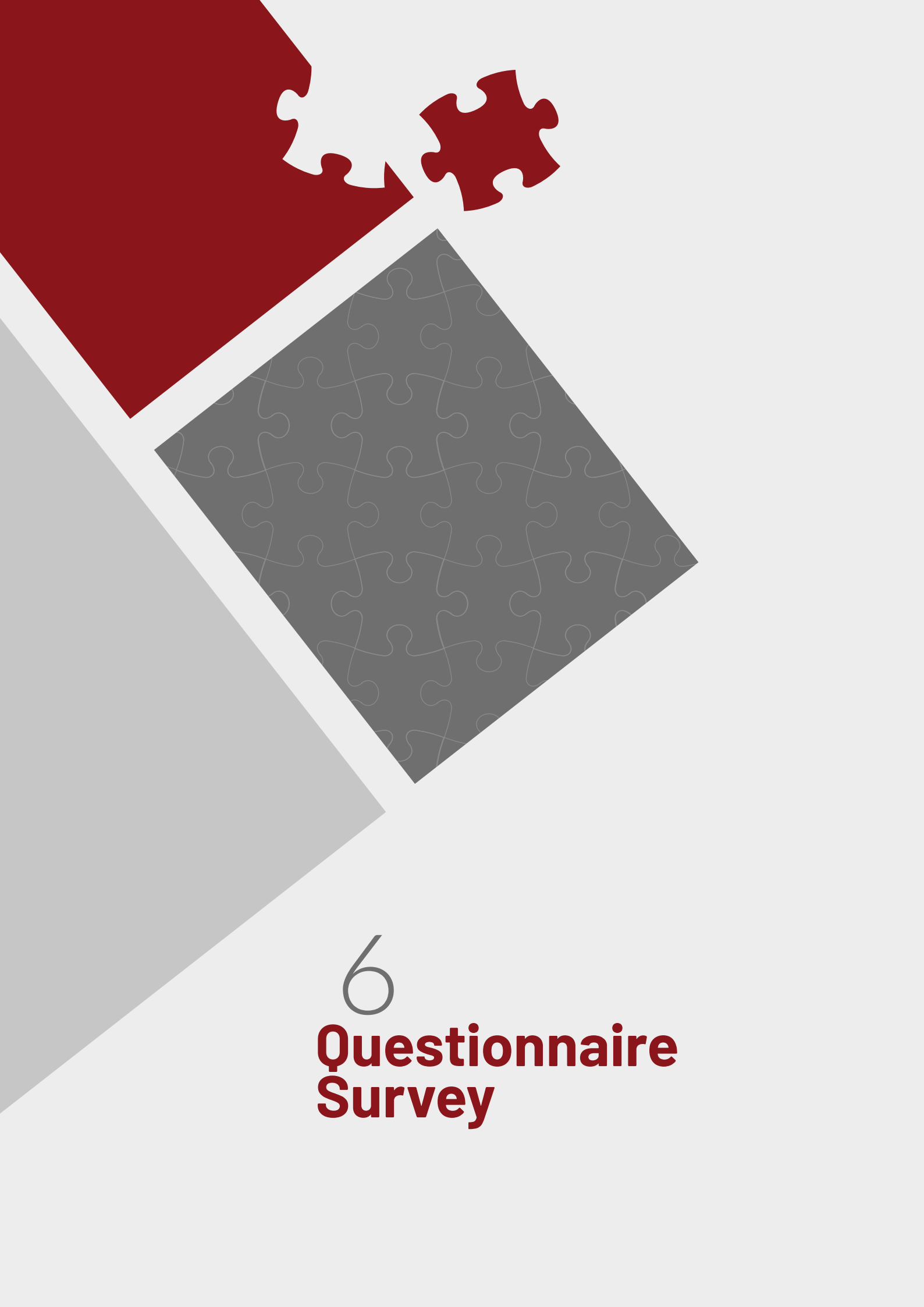
For Odder Barnevognsfabrik, product safety and quality are crucial. Only the best is good enough. All prams are tested according to the applicable European safety standard EN 1888, ensuring that the company meets the Danish Safety Authority's safety requirements for prams. Therefore, the prams are both safe and practical to use.

The company faced challenges with supply shortages and delays/extended delivery times due to the COVID-19 crisis. It also experienced dependency on suppliers (single source). There are long distances between suppliers, for example, in China and the factory in Odder. Additionally, communication was more difficult during the pandemic as physical meetings were not possible, and local restrictions, especially in China, posed challenges.

Through their participation in the project, Odder Barnevognsfabrik identified various vulnerabilities that require attention, such as meeting CSR/sustainability/UN Sustainable Development Goals, reducing dependence on key personnel, and improving their systems. To address these vulnerabilities, the company implemented several initiatives, including enhancing sustainability practices (e.g., obtaining eco-label certification), identifying and developing more sustainable suppliers, strengthening internal documentation, fostering cross-functional collaboration, and establishing comprehensive system overviews.

> ***The Supply Chain Resilience process has provided us with a shared understanding of our company and the actual challenges we face. Through individual analyses, we have contributed our unique perspectives, resulting in a comprehensive overview of the areas where we need to focus and where we can generate the most value for our operations and, ultimately, for everyone involved.***

- Birgitte Hede Sørensen, Odder Barnevognsfabrik A/S



6 Questionnaire Survey

During the spring of 2023, a national questionnaire survey was conducted to assess the Supply Chain Resilience practices of Danish manufacturing companies. This section provides an overview of the main findings from the survey.

6.1 Method

The survey was carried out as a national questionnaire survey, targeting manufacturing companies in Denmark. Company data from Bisnode and Orbis databases were utilized to extract information from manufacturing companies employing 20 to 250 individuals. Initially, a gross list of 1,202 companies was obtained, excluding those with advertising protection. To refine the list, bakeries (which appeared for unclear reasons) and inactive companies were excluded, resulting in a net list of 1,113 companies. An email communication was sent to these companies. Additionally, 65 large companies were contacted using a database compiled from previous surveys, bringing the total number of contacted companies to 1,178.

To identify appropriate email contacts, students assisted in visiting company websites and retrieving contact information for individuals responsible for supply chain or production. In cases where this information was not available, the company's CEO was contacted. If email information could not be found, the companies were contacted via phone to inquire about their willingness to participate. Alternatively, the email address was obtained from the appropriate contact person. Out of the 1,178 contacted companies, 340 expressed interests in participating, 222 declined, and there was no response from the remaining 630 companies. Among the 340 interested companies, 246 successfully completed the entire survey, forming the dataset for the survey analysis.


PRESSALIT®

Pressalit A/S

(Data collected in autumn 2022)

Pressalit is a Danish privately-owned company, now in its third generation, with manufacturing facilities located in Ry, Denmark. Since 1954, Pressalit has been renowned for designing, developing, and manufacturing high-quality toilet seats. In addition, since 1975, the company has expanded its expertise to create flexible bathroom solutions for individuals with reduced mobility. As a result, Pressalit has established itself as one of the world's leading manufacturers of top-quality bathroom solutions. The company's extensive product range is characterized by its emphasis on high quality, exquisite design, and functional completeness. With approximately 300 employees, comprising 150 salaried and 150 hourly workers, Pressalit maintains a global presence with offices in nine countries and representation in 45 countries worldwide. One of the company's fundamental core values is "integrity." In terms of revenue distribution, Europe accounts for 93%, North America for nearly 5%, and Australia for just under 2% of the total. In Denmark, production is divided among three units: brackets, toilet seats, and CARE, alongside a logistics center located in Ry. Pressalit offers a vast array of products, including 2,600 finished items, 2,200 semi-finished products, and 2,650 raw materials.

Throughout the process, Pressalit identified several vulnerabilities, such as a lack of sales, customer dependency, geopolitical disruptions, and limited availability of raw materials. Consequently, a set of capabilities were identified that required development to address these vulnerabilities. These include improving forecasting, implementing Sales & Operations Planning, enhancing marketing efforts, acquiring new customers, maintaining cost focus, assessing supplier vulnerabilities related to geopolitics, and embracing modular product design. Supplier risk mapping is currently underway within the company. During the COVID-19 crisis, inventory levels were increased as a precautionary measure, and a subsequent initiative titled "healthy inventories" is now underway to reduce excess stock.

Participating in the project has provided Pressalit with a structured and focused process. It has fostered a shared understanding and self-insight among the top management team. The predefined vulnerabilities and capabilities have facilitated the development of a common language. Significant progress has been made with relatively minimal effort, resulting in the identification of broader action areas that extend beyond the supply chains. The company's focus now lies on executing the action plan and ensuring follow-up, as directed by the Pressalit Management Team.

> ***Participating in the Supply Chain Resilience project with SDU has enhanced Pressalit's self-insight and created a shared understanding of supply chain vulnerabilities. The method employed, coupled with the introduction of new tools, has allowed us to gain an overview in a dynamic business environment and develop an action plan to address vulnerabilities.***
>
> - Henrik Damborg, COO, Pressalit A/S

6.2 Demographic Characteristics of the Respondents

6.2.1 Respondents' Organizational Level

The 246 respondents had the opportunity to indicate three specific organizational titles as well as an 'Other' option, as shown in Figure 6.1. As depicted in Figure 6.1, CEOs account for 28% of the respondents, COOs account for 20%, supply chain managers/production managers account for 30%, and the category 'Other' represents 22% of the respondents. The 'Other' category includes job positions such as procurement managers, directors of development, and logistics managers. Hence, the dataset primarily consists of senior leaders.

6.2.2 Company Sizes

In terms of company sizes, as shown in Figure 6.2, the majority of the surveyed companies (84%) are small and medium-sized enterprises (SMEs) with up to 250 employees, while 16% are large companies with over 250 employees.

6.2.3 Industries

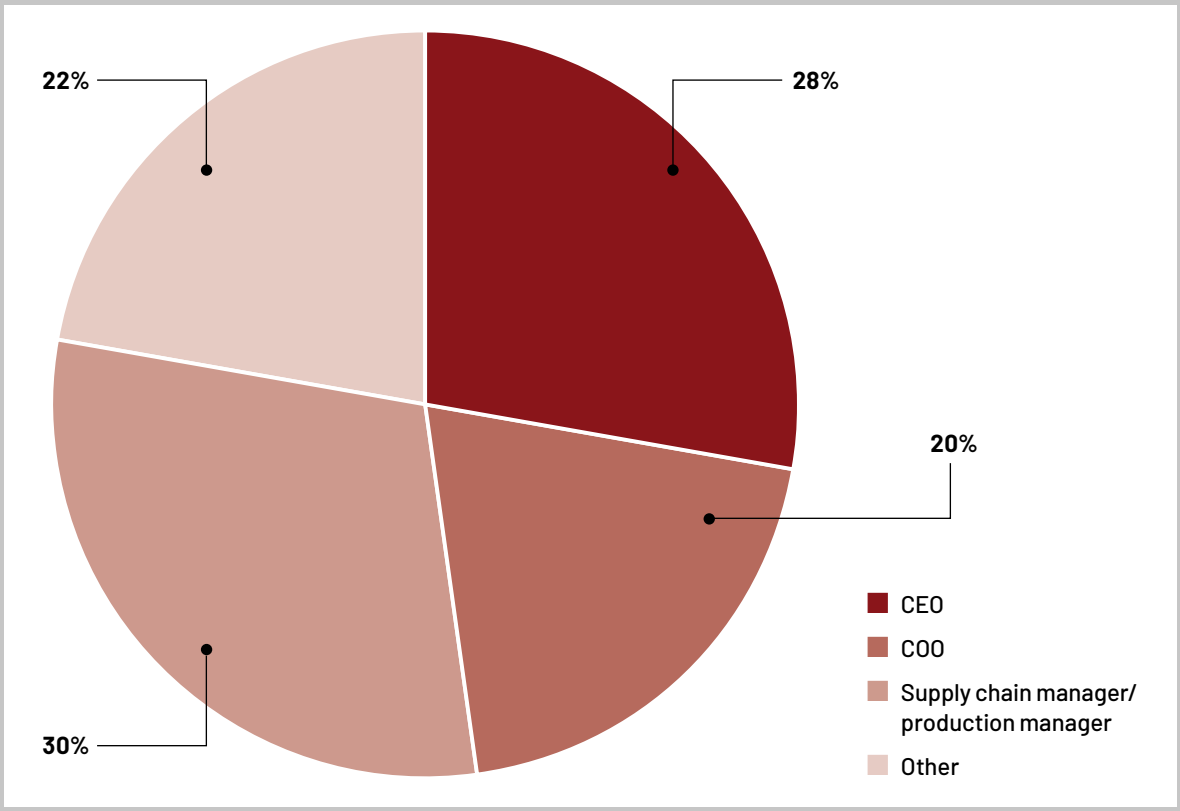
In terms of industry distribution, Table 6.1 provides an overview of the surveyed companies. Out of the 246 respondents, the industry category 'Manufacture of machinery and equipment not elsewhere classified' represents just over 20% of the respondents (53 out of 246).

Table 6.1: Distribution of the survey by industries

Industry	Number
Manufacture of food products (10)	21
Manufacture of beverage (11)	1
Manufacture of textiles (13)	4
Manufacture of wearing apparel (14)	1
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (16)	13
Printing and reproduction of recorded media (18)	3
Manufacture of chemicals and chemical products (20)	4
Manufacture of basic pharmaceutical products and pharmaceutical preparations (21)	5
Manufacture of rubber and plastic products (22)	26
Manufacture of other non-metallic mineral products (23)	2
Manufacture of basic metals (24)	8
Manufacture of fabricated metal products, except machinery and equipment (25)	36
Manufacture of computer, electronic and optical products (26)	8
Manufacture of electrical equipment (27)	14
Manufacture of machinery and equipment n.e.c. (28)	53
Manufacture of furniture (31)	7
Other manufacturing (32)	37
Repair and installation of machinery and equipment (33)	3
Total	246

Note: Numbers in parenthesis are the respective European NACE codes

Figure 6.1: **Respondents' organizational level**



Figue 6.2: **Number of employees**

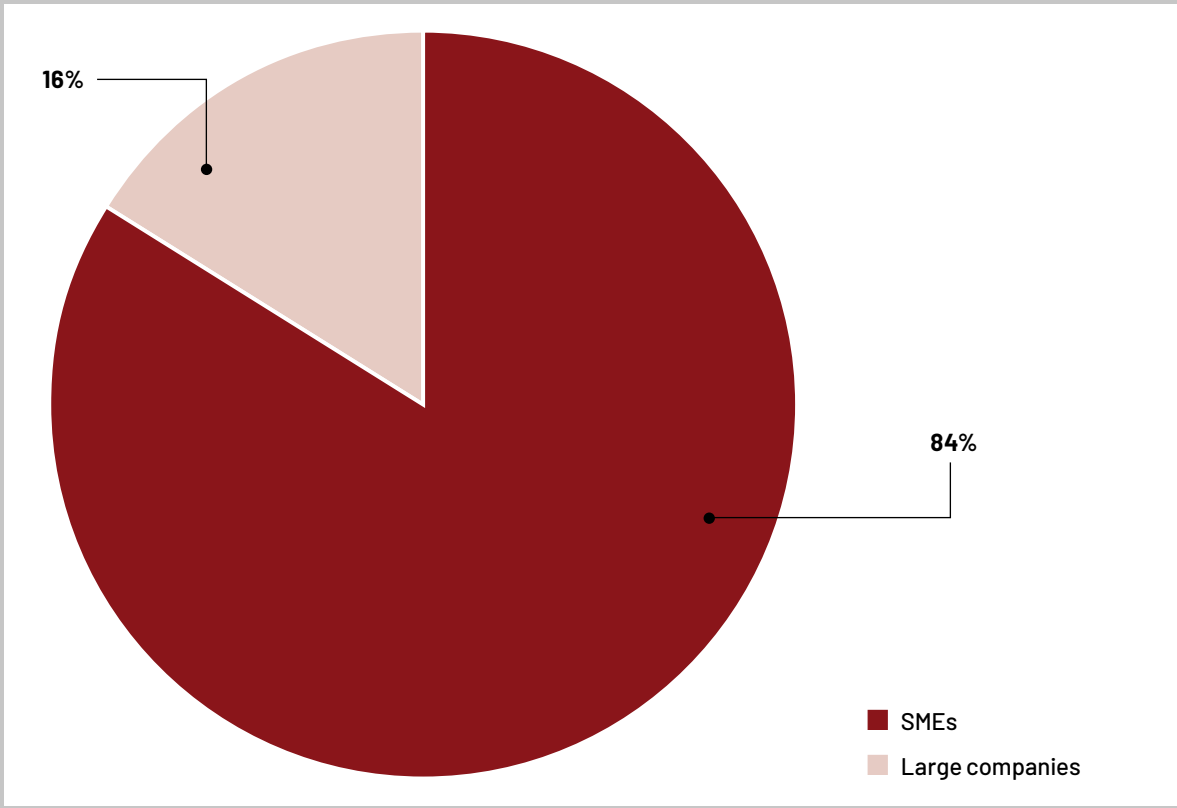
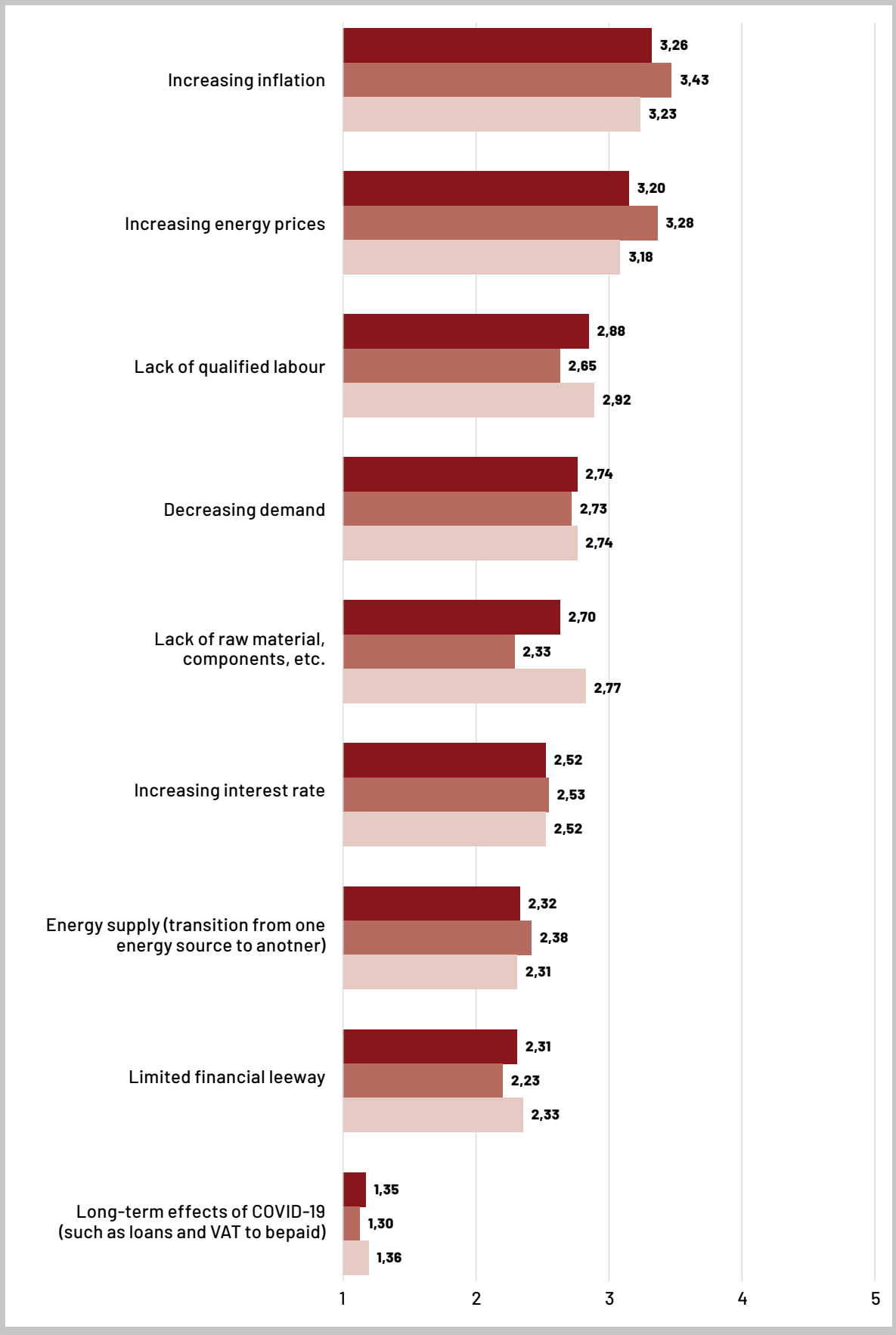


Figure 6.3: Factors affecting the competitive situation



The industries 'Other manufacturing industries' and 'Iron and steel industry, except machinery and equipment' are well-represented in the survey, each accounting for approximately 15% of the respondents (37 and 36 out of the 246 respondents, respectively). On the other hand, the industries 'Beverage manufacturing' and 'Manufacture of wearing apparel' have the lowest repre-entation in the survey, with only one respondent each.

6.2.4 Supply Chain Structure

Regarding the supply chain structure, the geographical distribution of the companies' customers is outlined in Table 6.2. Nearly half of the customer base, 48%, is located in Denmark. 36% of customers are located in the rest of Europe, 5% in Asia, and 8% in North America. The remaining 3% is distributed among customers located in South America, Africa, and Oceania.

The respondents were also asked about the location of their company's production. As shown in Table 6.2, 84% of the production value is carried out in Denmark, while 11% takes place in the rest of Europe.

This means that 95% of the production value is generated within the nearby European region. North America and Asia contribute only 2% each to the production value, while production in South America, Africa, and Oceania is negligible. Furthermore, Table 6.2 illustrates that 57% of the companies' suppliers are located in Denmark, with an additional 34% situated in the rest of Europe. Asia accounts for 7% of the supplier base, while North America accounts for 2%. None of the companies source their supplies from South America, Africa, and Oceania.

6.3 Impact on Competitiveness

Companies are influenced by various factors that can impact their competitive position. Some factors, such as "Monopoly" or "Unique patents," have a positive effect on the company's competitiveness, while others, like "Many competitors" or "Outdated product range," have a negative effect.

Table 6.2: Localization of customers, production, and suppliers

	Localization of Customers	Localization of Production	Localization of Suppliers
Denmark	48%	84%	57%
Europe (minus Denmark)	36%	11%	34%
Asia	5%	2%	7%
North America	8%	2%	2%
South America, Africa, and Oceania	3%	1%	0%
Total	100%	100%	100%

The respondents were asked to rate these factors on a five-point Likert scale, where 1 represents a very low degree and 5 indicates a very high degree of impact. Figure 6.3 presents the findings, highlighting that companies particularly identified "Rising inflation" as an impacting factor, with an overall average rating of 3.26. Additionally, "Rising energy prices" was considered impactful, with an overall average rating of 3.20.

Although increasing inflation and energy prices have a moderate impact on companies' competitive situation, the data reveals that small and medium-sized enterprises (SMEs) weigh these factors lower than large companies. Following closely is the factor of "Lack of qualified workforce" with an overall average rating of 2.88. It is surprising that companies only experience a moderate level of workforce shortage, as this issue is often highlighted as a major concern. Rejection of orders due to a lack of qualified workforce is a common practice, hence it was expected to have a more pronounced impact. Interestingly, large companies report an even lower shortage of qualified workforce compared to SMEs, suggesting that SMEs may be less attractive to potential employees. However, it remains unclear whether the lack of qualified workforce is as significant as portrayed in the media or if it varies across industries.

All other factors in the survey receive average ratings below 3.00. Notably, the "Long-term effects of COVID-19 (e.g., loans and VAT to be repaid)" appears to have minimal impact, with an average rating of only 1.35. Contrary to media emphasis, the shortage of goods, such as components and raw materials, has only a moderate effect on companies' competitive situation, with an average rating of 2.70.

One possible explanation is that companies perceive this shortage as a shared challenge among competitors, thereby considering it less detrimental to individual competitiveness. However, the data suggests that SMEs view the lack of raw materials and components as more influential compared to large

Figure 6.4: Lack of qualified workforce

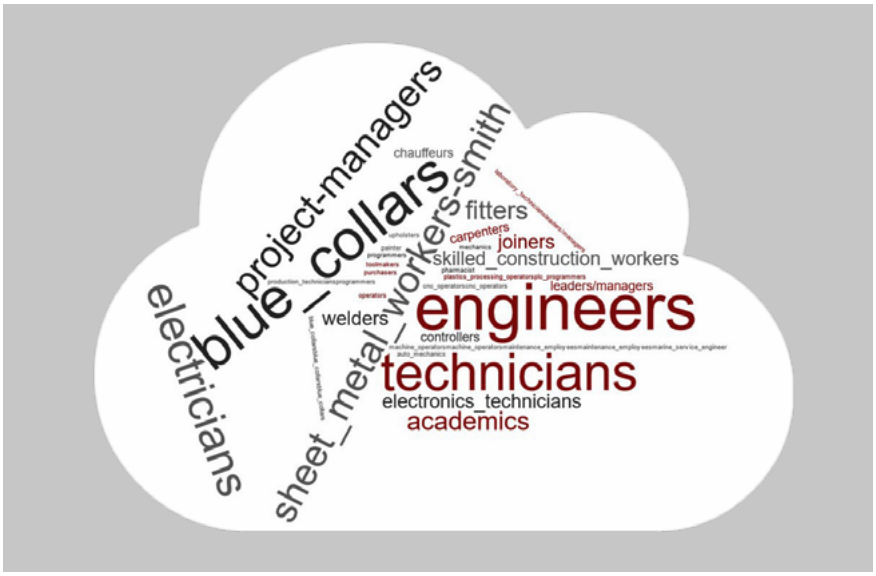
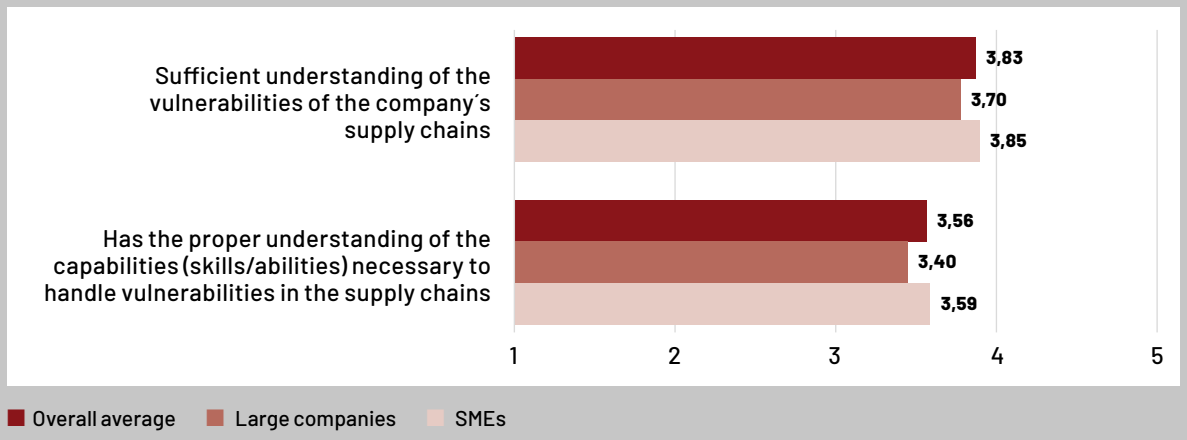


Figure 6.5: Respondents' understanding of vulnerabilities and capabilities needed to address them



companies. This implies that suppliers may favor large companies over SMEs, potentially leading to significant consequences for SMEs if they cannot meet customer demands due to limited access to essential resources. Respondents who indicated a lack of qualified workforce were asked to specify which types of workers are in short supply.

Figure 6.4 illustrates that engineers, skilled workers, sheet metal workers, industrial technicians, and blue color workers are among the roles that companies struggle to find qualified candidates for.

6.4 The Understanding of Vulnerabilities and Capabilities

In this section, we will explore how companies perceive their own vulnerabilities and the corresponding capabilities required to address them. The analysis is divided into two groups: small and medium-sized enterprises (SMEs) with up to 250 employees and large companies with more than 250 employees. This division allows us to examine potential differences in responses between the two groups.

First, respondents were asked about the level of understanding of supply chain vulnerabilities within their companies. Subsequently, they were asked to assess their companies' understanding of the capabilities necessary to handle and address these vulnerabilities. Both questions were rated on a five-point Likert scale, where 1 indicates a very low or limited degree of understanding, and 5 indicates a very high degree of understanding. The responses to these questions are illustrated in Figure 6.5.

As depicted in Figure 6.5, companies reported an average of 3.83 when asked about their "sufficient understanding of vulnerabilities in supply chains." This

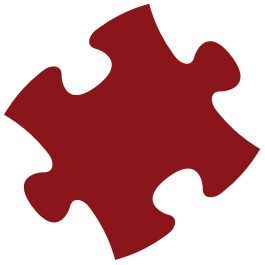
finding is noteworthy considering a previous study (Stentoft & Mikkelsen, 2020) that asked a similar question about companies' awareness of risk factors in their supply chains. In that study, the five-point scale yielded an average of 3.05, indicating a moderate level of understanding. One possible explanation for the discrepancy in average values between the two studies could be attributed to the timing. Companies in the 2020 study might have been amid experiencing the impact of COVID-19, while participants in the current study have had time to reflect and gain insights into the vulnerabilities within their supply chains.

Interestingly, SMEs exhibited a better understanding of supply chain vulnerabilities with an average of 3.85, whereas large companies appeared to have a lower level of insight with an average of 3.70. One could intuitively assume that larger companies, with more resources, would be better equipped to gain such insights compared to SMEs. However, the characteristics of SMEs, as outlined in Table 2.1, such as flatter organizational structures, fewer management layers, and more agility, may facilitate faster information dissemination and quicker decision-making within SMEs. Additionally, SMEs' supply chains may be less complex, which contributes to a swifter dissemination of information and prompt decision-making.

Figure 6.5 also reveals that companies do not perceive themselves to have the same level of understanding regarding the necessary capabilities (skills/competencies) required to address vulnerabilities in their supply chains. The overall average rating on the five-point Likert scale is 3.56.

In studies like the present one, ratings of 3.50 and above are considered significant. Once again, it is somewhat surprising that SMEs exhibit a better understanding of the necessary capabilities, with an average rating of 3.59, compared to large companies with an average rating of 3.40. This could be attributed to SMEs being more closely connected to the operational level, allowing them to recognize the efforts needed to address each vulnerability. However, both groups express a desire for a higher level of understanding on how to address vulnerabilities and enhance resilience within their supply chains.

This could be attributed to SMEs being more closely connected to the operational level, allowing them to recognize the efforts needed to address each vulnerability.



SANOVO
TECHNOLOGY GROUP

SANOVO TECHNOLOGY GROUP A/S

(Data collected in autumn 2022)

SANOVO TECHNOLOGY GROUP was established in 1961 as a pioneering company in the egg industry, specializing in complete egg-breaking machines. The company's headquarters are located in Odense. Today, SANOVO TECHNOLOGY GROUP is a global enterprise with nearly 600 employees and a worldwide customer base. The company is a world leader in providing process solutions for the egg industry. It operates through its own service and sales offices across six continents and has production facilities in Denmark, the Netherlands, Slovakia, and Italy, making it a leading global partner in the egg industry. In addition to its expertise in the egg industry, SANOVO TECHNOLOGY GROUP is also involved in various other business areas such as enzymes, pharmaceuticals, hatcheries, and spray drying of alternative protein sources. This diversification allows for collaboration and relationship building in multiple industries.

The company's business areas are categorized as follows: **EGG** (packing, grading, processing, robotic), **POULTRY** (packing, grading, in-ovo vaccination, robotic), **SANOVO TECHNOLOGY PROCESS** (spray drying and pasteurization of other proteins)

SANOVO TECHNOLOGY GROUP is part of THORNICO, a private company owned by Thor and Christian Stadil. THORNICO has an extensive portfolio of companies operating in the food industry as well as other sectors such as shipping, real estate, and sportswear. During the project, areas were identified where SANOVO TECHNOLOGY GROUP could strengthen its supply chains. These included challenges with bottleneck suppliers who were the sole providers, long delivery times from suppliers, and shortages of raw materials like plastic. These issues put pressure on the production process, requiring frequent adjustments due to supplier shortages. The company also faced challenges with goods receiving, leading to excessive inventory accumulation and warehouse space constraints. Furthermore, the spare parts market posed difficulties due to the purchase of alternative items in large quantities. Through the project, SANOVO TECHNOLOGY GROUP recognized several vulnerabilities, including internal communication issues, low data quality, frequent changes in orders, and insufficient availability of raw materials. Consequently, the company focused on improving follow-up processes for prototype initiation, enhancing data quality to reflect accurate costs, implementing clarification procedures in collaboration with project management and sales to understand the impacts of changes, and enhancing forecasting capabilities.

> ***Those of us who participated in the project had a positive experience, with productive interdisciplinary dialogues among different departments. This led our management to review internal processes to ensure alignment across departments in line with our internal procedures.***

- Daniel Riis Jensen, Category Manager, SANOVO TECHNOLOGY GROUP A/S

> ***SMEs are more agile in comprehending and disseminating experiences and knowledge, as well as taking prompt action in response to disruptions and unexpected events.***

6.5 Supply Chain Resilience

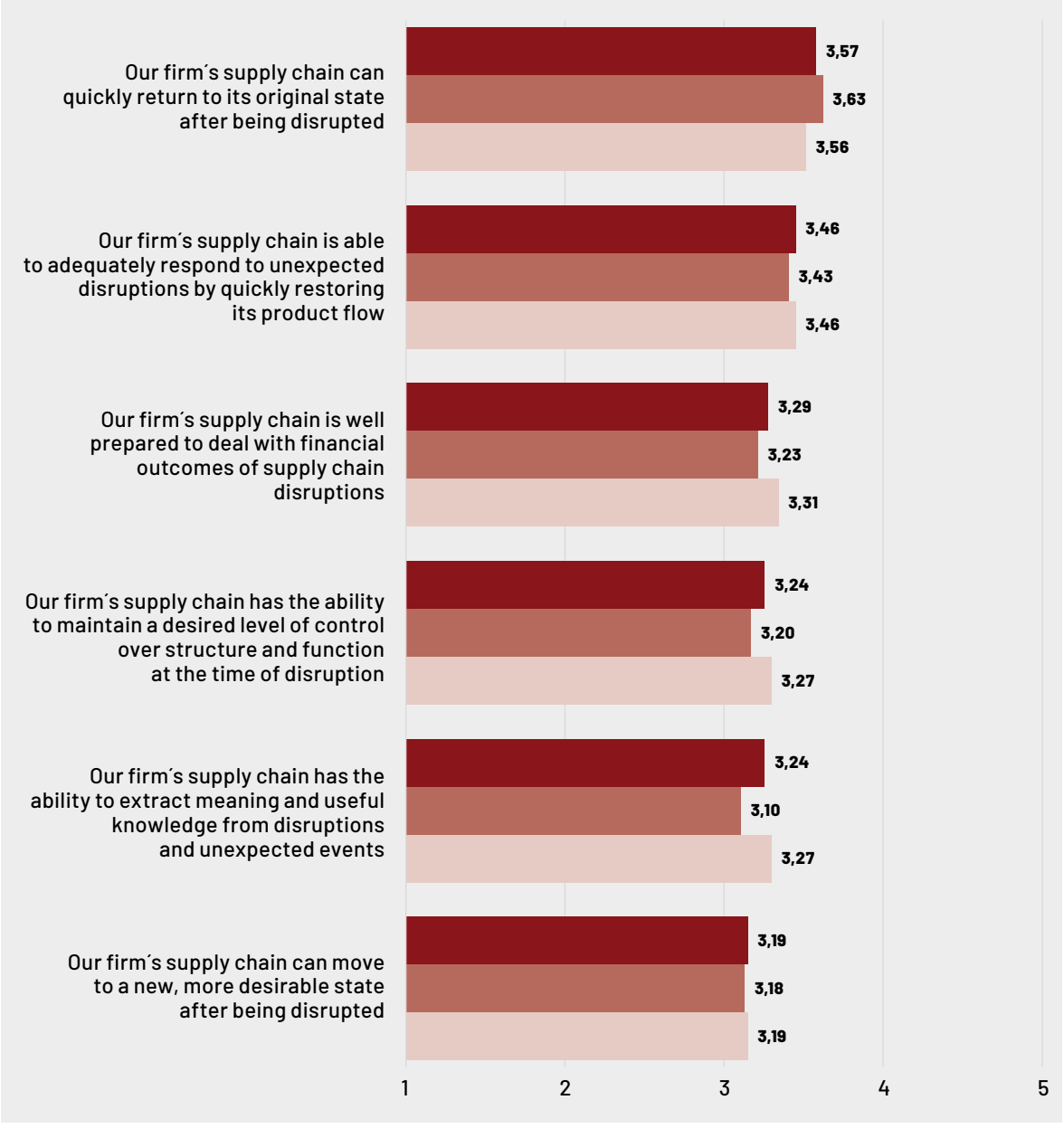
The survey included a set of questions aimed at assessing the level of Supply Chain Resilience within the company. Figure 6.6 presents the responses to each question, measured on a five-point Likert scale. The Supply Chain Resilience construct used in this study is based on the work of Gölgeci and Ponomarov (2015). As depicted in Figure 6.6, the average values range from 3.10 to 3.63 on a five-point Likert scale, where 1 represents "to a very low degree" and 5 represents "to a very high degree." In other words, the average values for each statement indicate a moderate level of agreement, hovering around "to some degree" (with an average of 3.00), without reaching the level of "to a high degree" (with an average of 4.00). The statement with the highest overall average of 3.57 pertains to the company's ability to swiftly recover its supply chain to its pre-disruption level. It is noteworthy that this is the only statement where large companies exhibit a higher average compared to SMEs, with an average of 3.63 for large companies and 3.56 for SMEs. Furthermore, it is the only statement with an average above 3.50.

In terms of the other statements, SMEs generally achieve higher averages than large companies, albeit the differences are marginal. However, one particular

aspect of Supply Chain Resilience in Figure 6.6 draws attention. SMEs indicate a slightly stronger ability to derive meaning and valuable knowledge from disruptions and unexpected events, with an average of 3.27 for SMEs compared to 3.10 for large companies.

This observation may seem paradoxical since large companies typically possess greater resources to capture, process, and implement knowledge for the company's benefit. One plausible explanation could be that due to their smaller size and reduced complexity, SMEs are more agile in comprehending and disseminating experiences and knowledge, as well as taking prompt action in response to disruptions and unexpected events.

Figure 6.6: Supply chain resilience




sbs
THE POWER TO STOP YOU®
MC09
sbs
GO AHEAD

SBS Friction A/S

(Data collected in late 2021/early 2022)

SBS Friction, headquartered in Svendborg, has been a part of the Italian Brembo Group (**www.brembo.com**) since January 1., 2021. Established in 1964, SBS Friction has grown into a globally renowned supplier of brake parts for motorcycles. The company serves 120 customers worldwide and distributes its brand through approximately 65 exclusive distributors.

SBS Friction specializes in providing brake pads and friction solutions for motorcycles, scooters, ATVs/UTVs, specialty vehicles, and industrial applications, including wind turbines. In the European motorcycle aftermarket, SBS holds the leading position. The core product of SBS Friction is brake pads and friction solutions, which are designed and manufactured at their Svendborg factory. The product portfolio also includes brake discs, clutch kits, brake shoes, and other trade products. SBS brake pads utilize NUCAP NRS technology, ensuring a durable and unbreakable bond between the friction material and the backing plate. The company follows an order-to-produce approach with a standard delivery time of two weeks. As an industry pioneer, SBS Friction achieved full compliance with the ECE R90 regulation, guaranteeing motorcycle riders the highest level of quality in terms of design, manufacturing, and performance. SBS Friction is committed to developing innovative and environmentally friendly products that will be gradually introduced into production and markets. Their clear objectives revolve around reducing the emission of harmful substances into the environment and seeking energy-efficient production solutions. SBS Friction employs around 120 people, with 98% of their products exported to approximately 40 countries, including the USA, Canada, Japan, Australia, and several EU countries. Despite the challenges posed by the COVID-19 pandemic, SBS Friction experienced increased sales, as the motorcycle market is driven by passionate enthusiasts.

Participating in the project highlighted several vulnerabilities within SBS Friction's supply network. These vulnerabilities encompassed issues related to raw material and supply availability, product purity requirements, limited materials, and dependency on unique raw materials and supplies. Geopolitical disruptions were also identified as potential vulnerabilities. To address these challenges, SBS Friction initiated various initiatives, such as identifying additional suppliers and supply sources, implementing multi-sourcing strategies, identifying common components across product groups, and enhancing early warning systems and information exchange.

> ***Our involvement in the project has fostered a shared understanding of the vulnerabilities present in our supply chains and the necessary capabilities we either possess or need to develop in order to effectively manage these vulnerabilities.***

- Torben Madsen, COO, SBS Friction A/S

6.6 Cybersecurity

One of the emerging challenges in relation to companies' supply chains is the threat of cyber-attacks. Both SMEs and large companies are increasingly vulnerable to cyber-attacks, including viruses like ransomware, which can disrupt production and hinder the delivery of products and services. It is, therefore, important to assess companies' knowledge of cybersecurity and the preventive measures they have implemented. The responses to the first question are presented in Figure 6.7, while Figure 6.8 provides insights into the preventive activities undertaken by the companies.

Figure 6.7 reveals that respondents have an overall average rating of 3.49 when asked about their knowledge of cybersecurity. This finding aligns with recent research indicating a lack of cybersecurity knowledge among Danish manufacturing SMEs (ASCD, 2020). Considering the significant exposure to cybercrime, an average rating of 3.49 indicates room for improvement. It is essential to consider this within the context of the heightened cybersecurity requirements for companies, including manufacturing SMEs, which will be introduced through the EU's new NIS2 directive. The directive also underscores the low level of readiness among Danish SMEs. Small companies, in particular, need to prepare for the upcoming NIS2 requirements (Irisgroup, 2023).

It is not surprising that larger companies have a higher level of knowledge about cybersecurity compared to SMEs. Larger companies typically have more resources and dedicated IT departments responsible for cybersecurity. On the other hand, in SMEs, IT and cybersecurity are often not separate entities but rather part of a task portfolio handled by a middle manager who also has various other responsibilities. While knowledge about cybersecurity is important, implementing preventive measures in practice is crucial. To assess the extent of preventive activities and the adoption of guidelines for handling cyber-attacks, we refer to the study conducted by Cheung et al. (2021). Figure 6.8 presents the degree to which companies have implemented preventive activities in relation to cybersecurity.

As shown in Figure 6.8, companies primarily rely on more traditional preventive activities such as access control, certified hardware and software, firewalls, and gateways. These activities are reported to be implemented to a high ex-

Figure 6.7: Necessary knowledge about cybersecurity

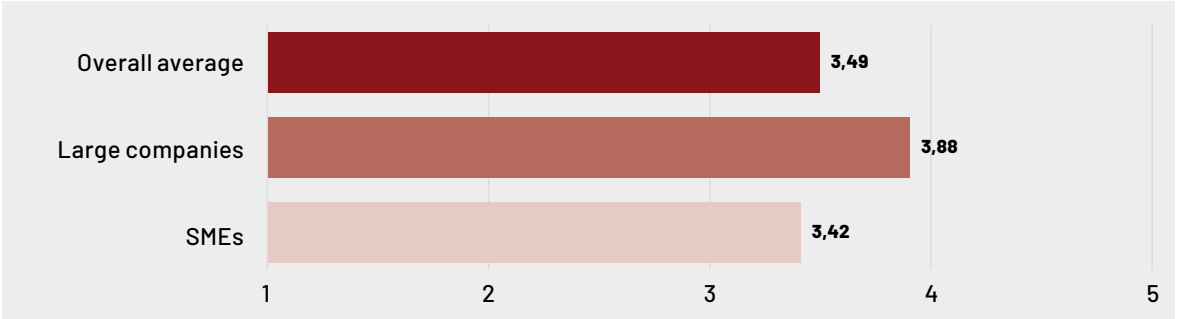
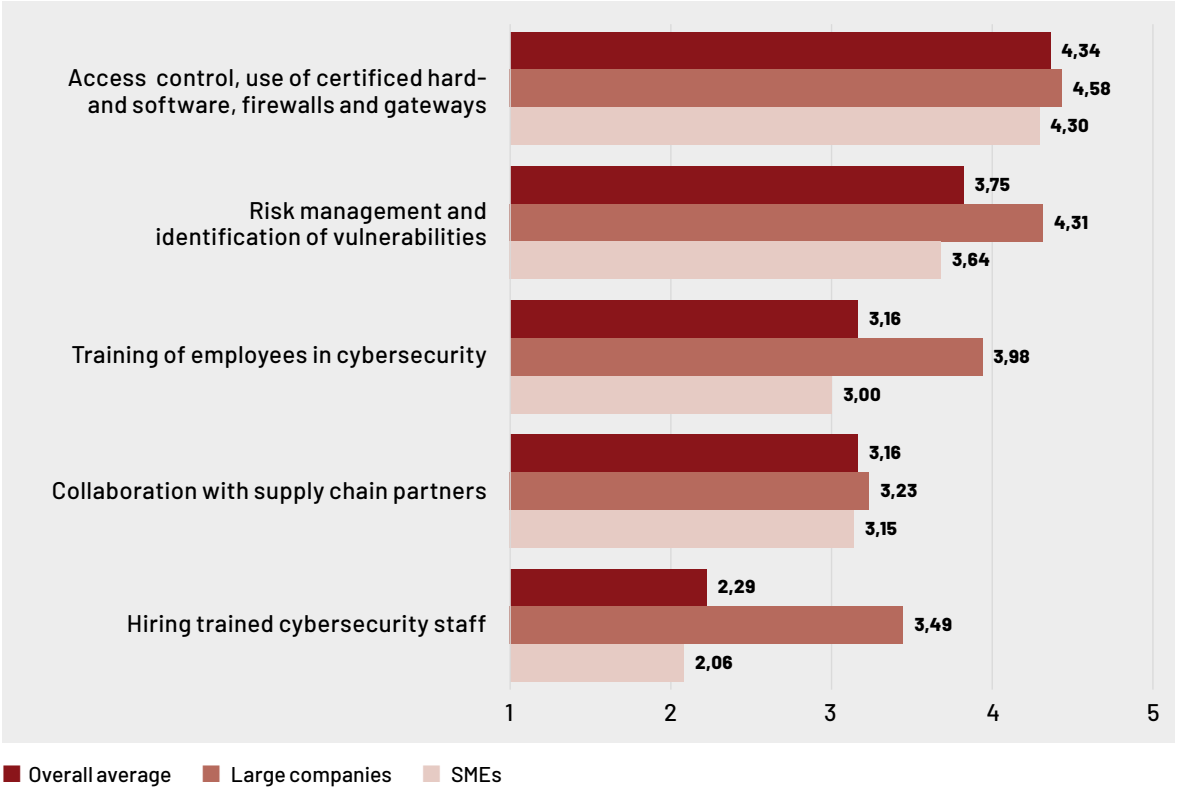


Figure 6.8: Implementation of preventive activities in relation to cybersecurity



tent, with an average score of 4.34 on the five-point scale. Large companies, in particular, have embraced these preventive measures with an average score of 4.58. The activity of "risk management and identification of vulnerabilities" follows closely with an average score of 3.75. Once again, large companies shows higher engagement in this area, averaging at 4.31, compared to SMEs with an average of 3.64. Employee training in cybersecurity, on the other hand, reaches a level close to "to some extent" with a score of 3.16. However, there is a significant disparity between the two groups, as SMEs average at 3.00 (to some extent), while large companies score higher at 3.98. Collaboration with supply chain partners on cybersecurity occurs to some extent, with an overall average score of 3.16. There is no notable difference between SMEs and large companies in this aspect. However, there is a significant difference in employing trained cybersecurity personnel. SMEs indicate this to a lower degree, with an average score of 2.06, while large companies make greater use of hiring trained employees, averaging at 3.49. Overall, these results underscore the resource advantage of large companies, enabling them to allocate more resources to risk management in cybersecurity, train employees, and hire individuals with specialized cybersecurity expertise.

Building on the above findings, it is also important to examine whether companies have established guidelines, policies, and procedures to handle potential cyber-attacks. Questions were asked about isolating the incident, ensuring real-time monitoring, and communicating the attack to relevant supply chain partners. As depicted in Figure 6.9, it becomes evident that large companies,

benefiting from greater resources, are more adept at developing procedures, policies, and guidelines to isolate incidents and ensure real-time monitoring, with average scores exceeding 4.00. SMEs, on the other hand, lag behind in these areas, with average scores of 3.43 and 3.31, respectively, for isolating the incident and ensuring real-time monitoring. Guidelines for communicating attacks to supply chain partners seem to be less prevalent. Once again, large companies outperform SMEs in this regard, although not to the same extent as the previous two factors. This outcome highlights the need for both SMEs and large companies to enhance collaboration on cybersecurity from a supply chain perspective, presenting an area for further development.

Furthermore, it is intriguing to explore whether companies have established guidelines, policies, and procedures for post-cyber-attack actions. The responses to this inquiry are presented in Figure 6.10.

Figue 6.9: Guidelines, policies, and procedures for handling cyber-attacks

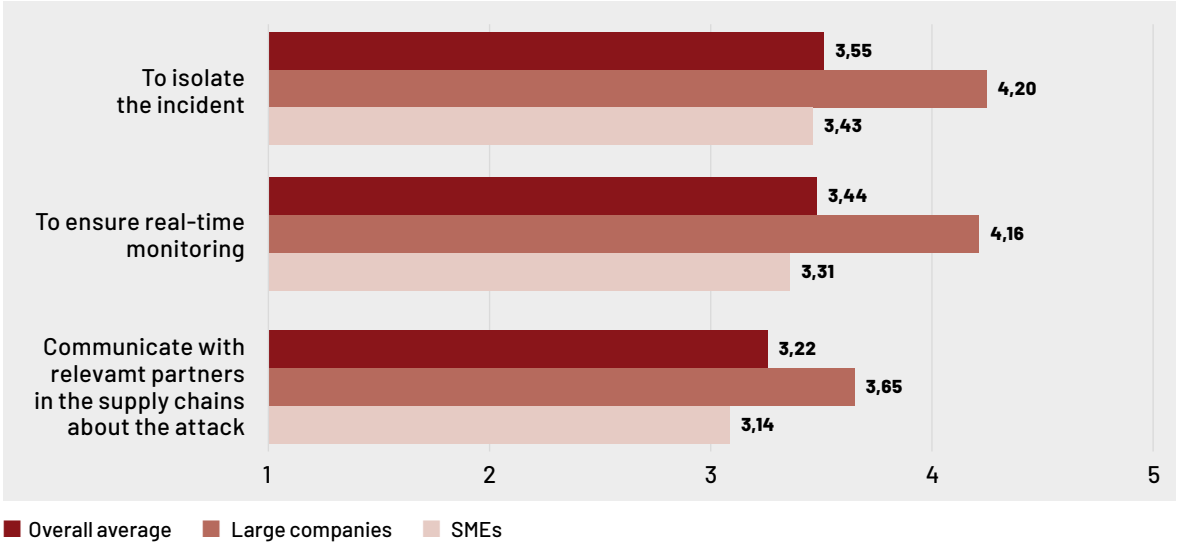
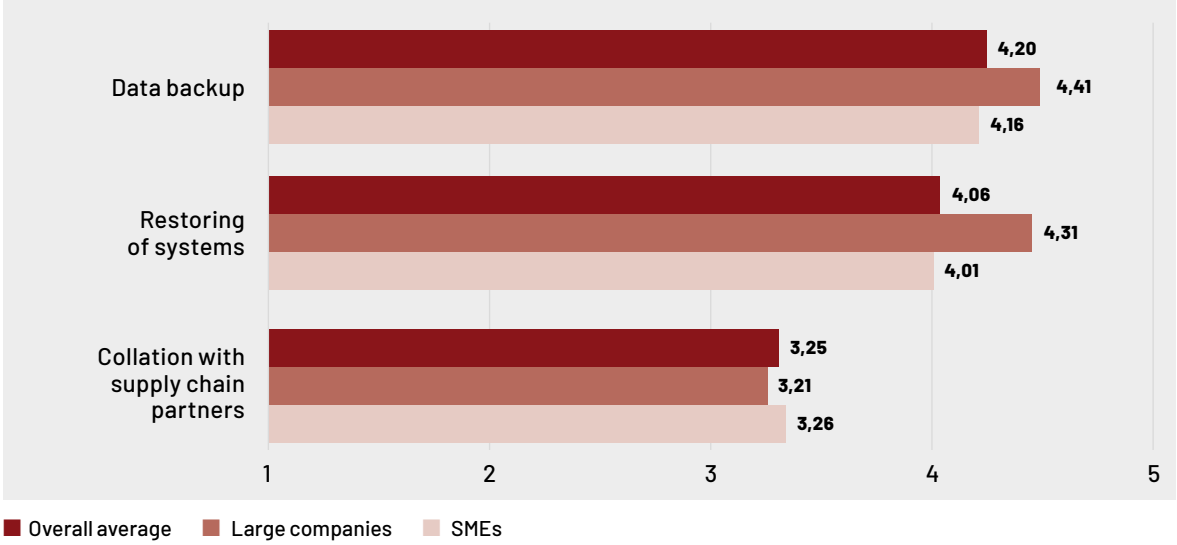


Figure 6.10: Guidelines, policies, and procedures for post-cyber-attack actions



As depicted in Figure 6.10, companies have established guidelines, policies, or procedures for data backup, with an average rating of 4.20, and system restoration, with an average rating of 4.06. Once again, the data highlights the resource limitations of SMEs, as they show lower average values compared to large companies. SMEs have an average rating of 4.16 for data backup, whereas large companies have an average rating of 4.41. Similarly, SMEs have an average rating of 4.01 for system restoration, while large companies have an average rating of 4.31. In terms of collaboration with partners in the supply chain, companies have not developed as many procedures, guidelines, or policies. The implementation of such measures is reported to be to some extent, with an overall average rating of 3.25. This indicates the need for further development in this area.

Overall, these findings highlight a significant gap in cybersecurity knowledge and ongoing preventive measures in SMEs. The same applies to the availability of guidelines, policies, or procedures for handling cyber-attacks during the attack itself. Consequently, there is a pressing need to enhance cybersecurity competencies in SMEs, particularly considering the forthcoming NIS2 requirements from the EU.

Tonica Elektronik A/S

MagVenture

Tonica Elektronik A/S /MagVenture A/S

(Data collected ultimo/primo 2022)

Tonica Electronik (TE) is a fully family-owned company situated in Farum. Established in 1992, TE is a knowledge-intensive organization specializing in the development and manufacturing of medical equipment. The company primarily focuses on the production of magnetic stimulators for treating depression and various addictions. TE also provides transcranial magnetic stimulation (TMS) for OCD treatment. The company's vision is to offer new hope to patients by revolutionizing the treatment of mental health conditions. The products are marketed under the brand name MagPro through their subsidiary, MagVenture A/S, and are recognized as a global leader. Approximately 98% of the production is exported and sold worldwide, with subsidiaries in the USA, UK, Germany, Brazil, and China, along with a distribution network in over 60 countries. TE operates on a make-to-stock production model, with the USA being their primary market. Sales are categorized into segments such as psychiatry, neurology, and rehabilitation. Despite facing competition and product replication attempts, TE has been continuously growing and currently employs over 150 people across its headquarters and four subsidiaries in Farum. During the COVID-19 pandemic, TE encountered delays in the availability of even minor components that were previously easily accessible, resulting in lead times ranging from 6 to 26 weeks. Agreements pertaining to supplier-managed inventory were also terminated. Although TE experienced growth due to a higher prevalence of mental disorders, the company initially witnessed a decline in orders during the pandemic's onset. Additionally, TE faced escalating prices, particularly in terms of freight costs. To ensure timely delivery, additional inventory was produced in the USA, given its status as the primary market.

Throughout the project, several vulnerabilities were identified, including complexity, human resources and skills, dependence on unique raw materials and suppliers, supplier and production capacity, distribution capability, and security risks. In response, TE initiated various initiatives, such as cross-training employees to perform multiple tasks, delegation, enhancing cybersecurity measures, decentralizing critical resources, promoting employee involvement, and exploring additional suppliers and supply sources.

> ***During the COVID-19 pandemic, we encountered significant supply chain challenges, including component shortages and doubled lead times. Collaborating with the University of Southern Denmark on Supply Chain Resilience allowed us to gain a better understanding of our supply chains and identify areas of vulnerability. Equipped with an updated toolkit, we are now considerably more resilient to market changes.***

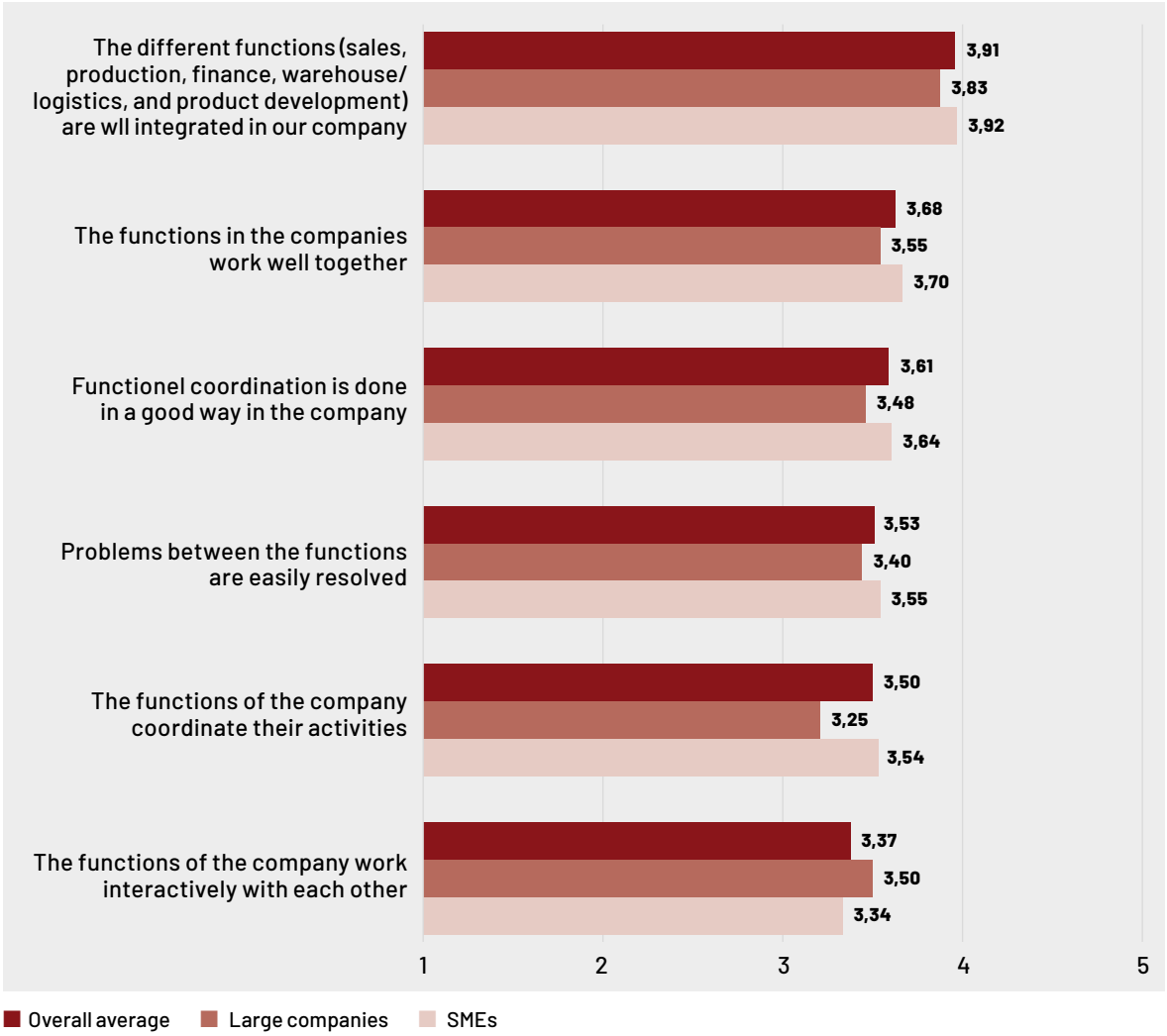
- Jacob Rasmussen, Purchasing Manager, Tonica Electronics / MagVenture A/S

6.7 Internal Integration

In Supply Chain Management, the concept of "silo culture" has been a focus for many years. It refers to individual functions such as sales, production, and procurement primarily prioritizing their own goals, potentially leading to sub-optimization and a lack of emphasis on the cross-organizational aspect. Internal integration between functions is a mean to overcome this silo culture. Therefore, it is important to investigate the level of internal integration within the companies of the respondents.

To measure internal integration, we have employed the construct developed by Turkulainen & Ketokivi (2012) (see Figure 6.11). As shown in Figure 6.11, the respondents generally believe that their companies have a good level of internal integration, with an average rating of 3.91 on a five-point Likert scale. Interestingly, the data suggests that larger companies exhibit lower levels of integration compared to SMEs. The functions within the companies are perceived to "work well together" with an average rating of 3.68, and here again, SMEs achieve slightly higher average values compared to larger

Figure 6.11: Internal integration



companies. This is followed by "Functional coordination occurs effectively in the company" with an average rating of 3.61, "Problems between functions are easily solved" with an average rating of 3.53, and "The company's functions coordinate their activities" with an average rating of 3.50. In all of these aspects, larger companies lag behind SMEs. Only in the statement "The company's functions work interactively with each other" with an average rating of 3.37, do SMEs show lower scores compared to larger companies. One possible explanation could be that larger companies have a greater need for interactive collaboration.

Earlier in the survey, it was revealed that larger companies, especially, have developed guidelines, policies, and procedures for cybersecurity. It is reasonable to assume that larger companies have also established guidelines and procedures for integration to ensure consistency in their operations. However, it is important to note that having numerous procedures and guidelines can be perceived as bureaucratic, potentially hindering efficiency and agility in getting things done.

In contrast, SMEs often have fewer formalized procedures and guidelines for integration, collaboration, and coordination, relying more on tacit knowledge. In other words, the formalization of processes through guidelines and procedures in larger companies may make them appear less integrating, collaborative, and coordinating than they actually are. On the other hand, SMEs typically have fewer employees who often have personal relationships, which may lead to perceiving the necessary personal interaction as a sign of higher integration, collaboration, and coordination.


Vikan
ADVANCING HYGIENIC CLEANING

Vikan A/S

(Data collected ultimo 2021/primo 2022)

Vikan is a leading company that specializes in the development, manufacturing, and marketing of professional cleaning solutions for the food industry and other hygiene-sensitive environments. Founded in 1898 and headquartered in Skive, Vikan serves over 90 countries as a global market leader. With approximately 250 employees across nine countries and production facilities in Denmark, Estonia, and the USA, Vikan is dedicated to providing effective and durable cleaning tools along with advanced services.

Being at the forefront of product development in its industry, Vikan has established itself as the standard-bearer for hygienic cleaning solutions. By leveraging its extensive knowledge of cleaning standards, methods, and technologies, combined with a unique innovation model that involves close collaboration with customers, Vikan is committed to delivering top-notch hygienic cleaning solutions worldwide. The company's primary objective is to assist customers in achieving their hygiene goals.

The company's core values are:

- Integrity
- Care
- Innovation
- Drive

90% of the company is owned by the Vissing Foundation, which supports patient-oriented research in cancer and diabetes, energy research, and initiatives aiding children and young people facing challenging living conditions (**www.vissingfonden.dk**). The remaining 10% is owned by CEO Carsten Bo Pedersen.

During the Covid-19 pandemic, Vikan faced significant challenges such as price increases in materials and transportation, scarcity of materials, and longer lead times. The company also encountered difficulties in accessing containers and obtaining raw materials. As part of the project, Vikan identified several vulnerabilities, including raw material and supply availability, dependence on unique raw materials and suppliers, price and exchange rate fluctuations, and issues related to human resources and competencies. In response, Vikan initiated various measures such as improving communication, providing training, implementing access restrictions, increasing employee involvement, enhancing forecasting capabilities, establishing closer relationships with suppliers to enhance attractiveness and priority, and seeking alternative suppliers.

> ***The participation in the project has allowed us to allocate time to systematically address vulnerabilities. This was one of the main reasons for joining the project. The involvement of external facilitators has added valuable dimensions to our discussions.***
>
> - Lars Aaen, Group Supply Chain Director, Vikan A/S

The lack of implementation capability for change projects can have various dimensions and significant consequences for companies.

6.8 Implementation Capability

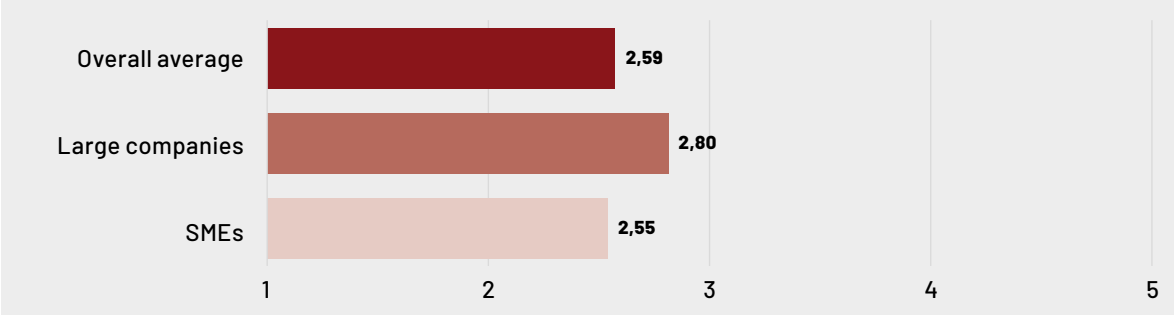
The survey included questions regarding the companies' capacity to execute change projects. Figure 6.12 illustrates the responses, indicating that respondents generally perceive their ability to implement such projects within their supply chains as limited. The overall average score is only 2.59 on the five-point scale, suggesting a need for improvement. Large companies have a slightly higher average of 2.80, while SMEs have a lower average of 2.55.

The lack of implementation capability for change projects can have various dimensions and significant consequences for companies. One dimension is the inability to fully comprehend the change project, leading to the company pursuing the wrong objectives. Another dimension is the absence of project management skills, resulting in projects failing to meet their goals or lacking necessary momentum. Additionally, it can involve a lack of ability to sustain and embed the changes after implementation.

It is not uncommon for organizations to lose focus and revert to old behaviors once projects are completed. This lack of implementation capability can result in wasted resources, including time and money.

Furthermore, it can undermine employee trust in change initiatives, impeding progress before it even begins. The structured process and collection of tools provided in this project aim to support the change process, particularly for SMEs. The vulnerability and capability tool, in particular, offers assistance in identifying and prioritizing critical aspects for the company's success

Figure 6.12: Ability to implement improvement projects



Vitrolife A/S

(Data collected ultimo 2021/primo 2022)

Founded in 2000 as the innovation company Unisense Fertilitech, which was acquired by Vitrolife AB in 2015, resulting in the current Vitrolife A/S, the company operates in Viby J and employs approximately 90 employees at its Denmark location. Vitrolife has a close to 100% export share and is part of the Vitrolife Group, an international corporation specializing in the development, manufacturing, and marketing of medical equipment for fertility treatments. With headquarters in Gothenburg, Sweden, and offices in multiple countries including the USA, Australia, France, Italy, the UK, China, Japan, and Denmark, Vitrolife sells its products in about 110 different markets, serving both private and public clinics. The Vitrolife share is listed on NASDAQ OMX Stockholm, Large Cap.

Vitrolife A/S is known for its flagship product, the Embryoscope, a state-of-the-art incubator equipped with time-lapse technology that captures images of each embryo at regular intervals during the incubation process. This enables advanced software to assist in determining the embryos with the highest chances of successful In Vitro Fertilization (IVF) treatment. Alongside the Embryoscope, Vitrolife also manufactures laser and Log & Guard systems, with service offerings playing a crucial role in generating revenue.

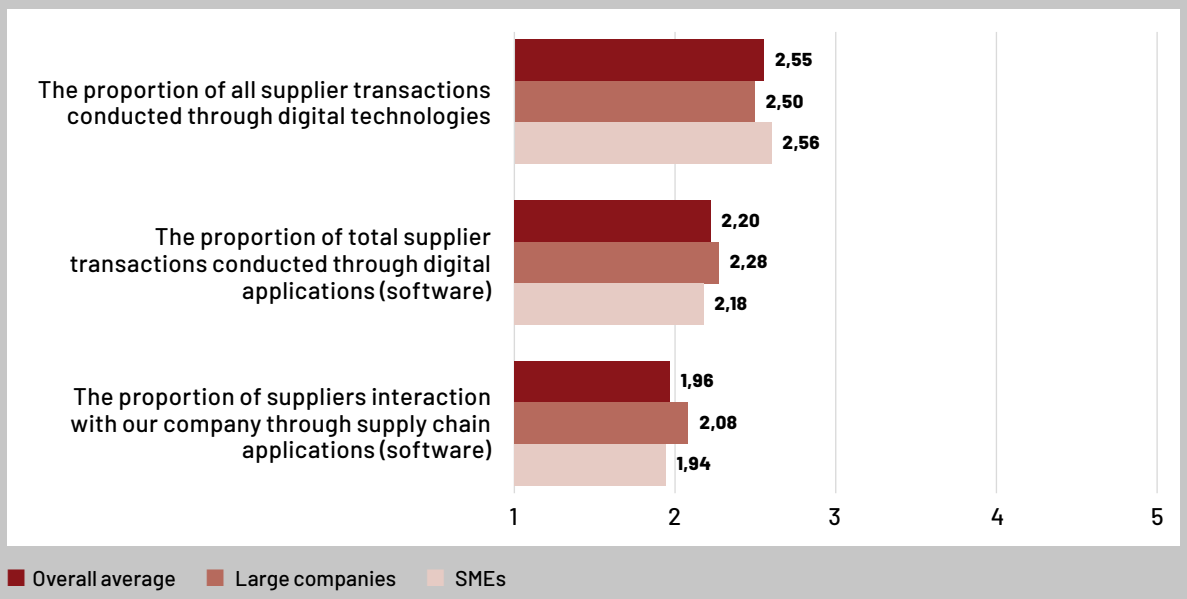
During the COVID-19 pandemic, Vitrolife faced significant challenges as IVF clinics were abruptly shut down, resulting in a rapid decline in business operations. Outbound activities towards suppliers were halted, and travel restrictions made it difficult to service equipment. Vitrolife encountered shortages of specific components that were redirected to the healthcare sector for ventilator production. Additionally, the company faced transportation challenges due to the pandemic's impact on logistics channels.

Through the project, Vitrolife identified various vulnerabilities that needed to be addressed, including human resources, dependency on unique raw materials and suppliers, availability of raw materials and supplies, freight challenges, geopolitical disruptions, and political/regulatory changes. To mitigate these vulnerabilities, the company implemented several initiatives such as redundancy and cross-training of employees, increased resource allocation, stronger supplier relationships, multi-sourcing strategies, and maintaining safety stock levels.

> ***We have transitioned from not giving much thought to potential impacts on our business to actively scheduling discussions and taking proactive measures. Since the onset of the pandemic, we have witnessed the occurrence of events such as wars and energy shortages. These circumstances have underscored the importance of staying vigilant and adaptable, as new challenges continually arise that could potentially affect us.***

- Lars Mogensen, Operation Manager, Vitrolife A/S

Figure 6.13: Digitalization of the supply chain



6.9 Digitalization of the Supply Chain

In a time where there is significant discussion in both academic and media circles about the potential performance improvement brought about by digitalization in companies' supply chains, it is intriguing to investigate whether and to what extent digital technologies are utilized in relation to external supply chain partners.

The results, as illustrated in Figure 6.13, indicate that there is considerable room for improvement in the areas mentioned. As shown, the 'Share of all supplier transactions conducted through digital technologies' is only indicated with an average score of 2.55 on a five-point Likert scale ranging from 1 = very low to 5 = very high.

The response to the 'Share of all interactions with collaborative partners conducted through supply chain applications,' is lower where an average of 2.20 is achieved. The 'Share of suppliers interacting with the company through supply chain applications' is even lower, with an average of only 1.96. For none of the three statements, there seem to be significant differences between large companies and SMEs.

The above findings suggest that the high expectations surrounding the potential of digital technologies in supply chain interactions have yet to be fully realized in actual company practices. These results align with a previous study that examined the utilization of digital technologies in companies (Stentoft & Mikkelsen, 2022). In that study, the use of digital technologies in

> ***The adoption of digital technologies for external interaction and integration is one aspect, while the utilization of software for internal processes is another.***

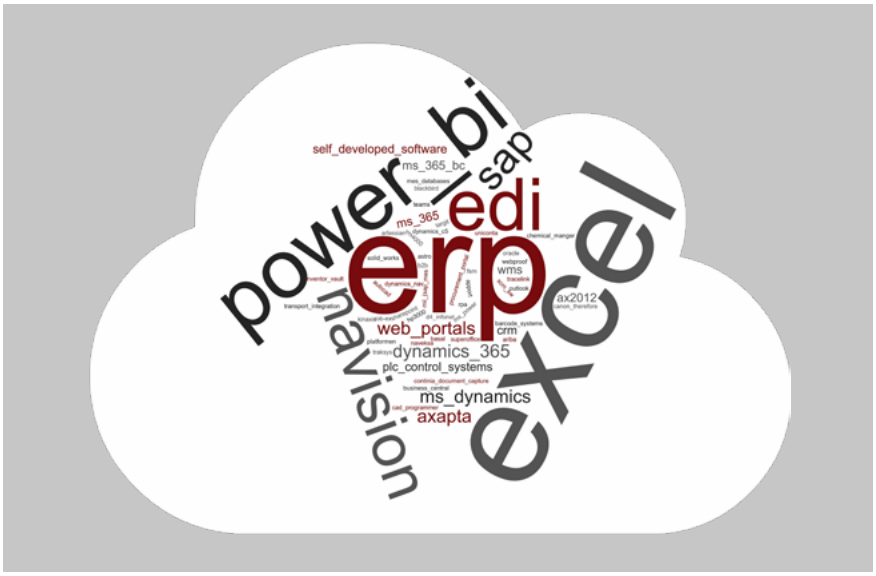
production processes, such as autonomous robots, big data analytics, Internet of Things, and artificial intelligence, all scored below 2.27 on a five-point Likert scale. In other words, there remains a substantial untapped potential for companies regarding external integration and interaction.

Respondents were given the opportunity to indicate the types of software they work with. As depicted in Figure 6.14, there appears to be a good level of adoption for Power BI, ERP, and Excel.

The adoption of digital technologies for external interaction and integration is one aspect, while the utilization of software for internal processes is another. Therefore, respondents were asked about this, and their responses are presented in Figure 6.15. As depicted in the figure, the use of software for internal processes is significantly more prominent compared to its use in external processes.

Unsurprisingly, "Invoicing and payment processes" are particularly well-supported by software, with an average rating of 4.20. Having control over both payments and invoicing is not only important but also facilitates legal reporting, such as VAT and annual financial statements. "Processing of purchase orders" and "Procurement management" follow closely, with average ratings of 3.87 and 3.75, respectively. These results are also expected since both processing purchase orders and procurement management are critical processes that

Figure 6.14: Use of software



> ***During the course of this project, the need for external assistance to implement or drive improvement projects in companies has become apparent.***

require accurate and precise information to inform production planning, including availability (quantity and time) and potential shortages. Such information significantly impacts production performance and commitments to customers concerning distribution and delivery. Subsequently, "Demand management/forecasting" is only moderately supported by software, with an average value of 3.04. However, there is a notable difference between SMEs and large companies, as large companies achieve an average of 3.30, while SMEs average at 2.99. Although the level is not high, it may indicate that SMEs have fewer resources compared to larger companies in terms of both staff and analytical capabilities. On the other hand, "Selection of suppliers (offers, bids, etc.)" is poorly supported by software, with an overall average value of 2.19. In other words, this process still heavily relies on manual methods, although some aspects may be conducted via email. Overall, the results suggest that planning-oriented activities are more strongly supported by software.

Figure 6.15: Use of software for internal processes

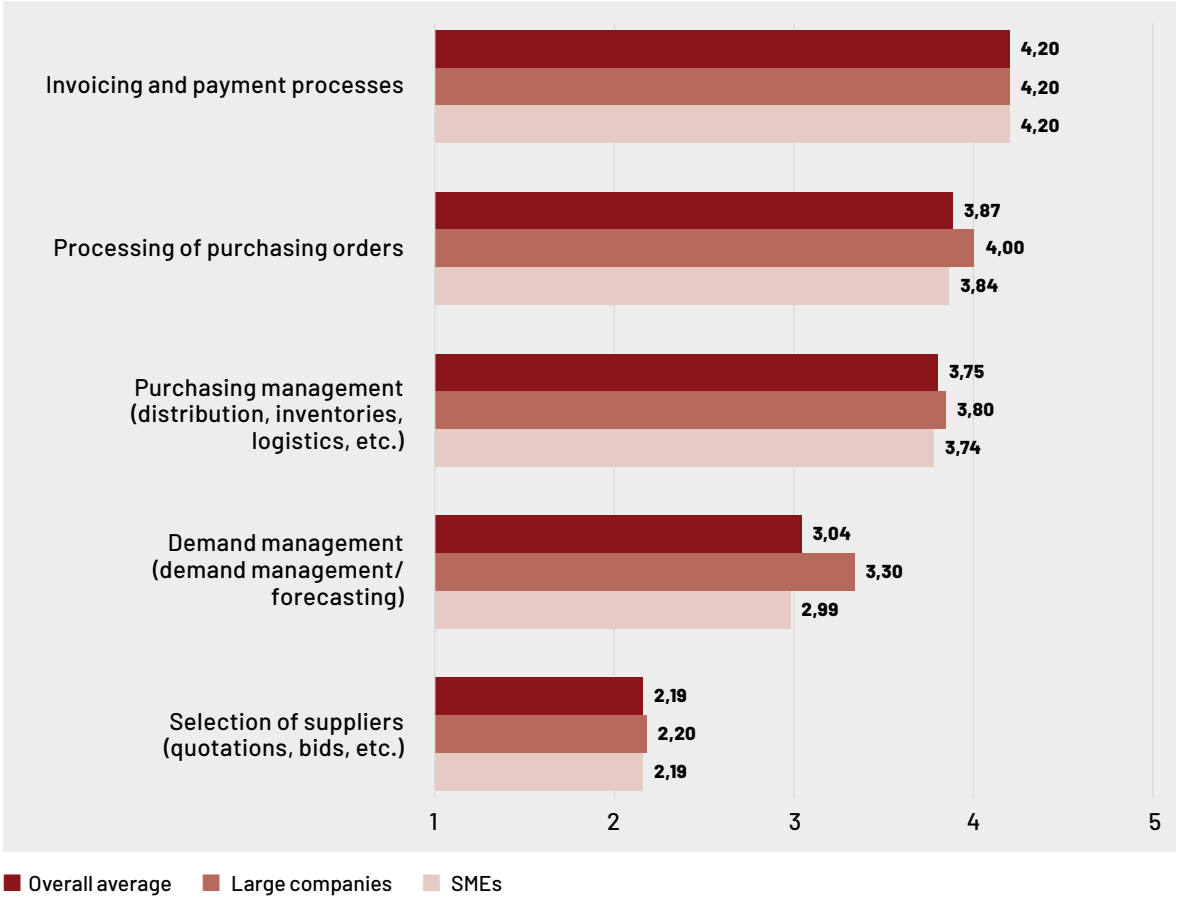
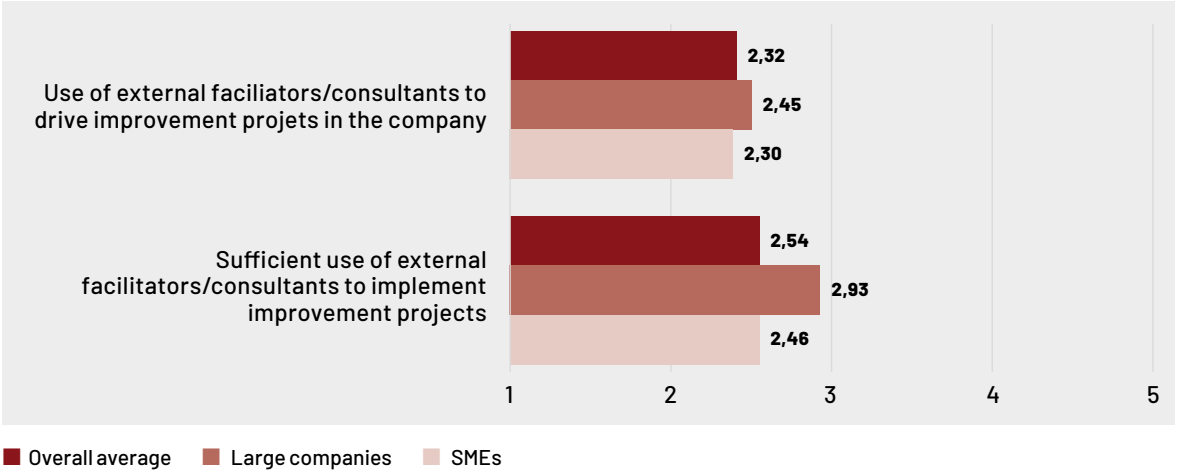


Figure 6.16: Use of external facilitators/consultants



6.10 Use of External Facilitators

During the course of this project, the need for external assistance to implement or drive improvement projects in companies has become apparent. Consequently, we also investigated the extent to which companies utilize external facilitators to drive and implement improvement projects. The responses are presented in Figure 6.16.

As depicted in Figure 6.16, there is not a significant utilization of 'External facilitators to drive improvement projects', with an overall average of 2.32. However, large companies show slightly greater inclination to seek external assistance compared to SMEs, scoring an average of 2.45, while SMEs average at 2.30. This trend may be attributed to the better financial capacity of large companies, enabling them to afford external support.

Furthermore, Figure 6.16 indicates that respondents from large companies perceive their current use of external facilitators or consultants to implement improvement projects as only moderately sufficient, with an average of 2.93. For SMEs, the level is even lower, with an average of 2.46. It's worth noting that although the level may be higher than the current usage, it is crucial to consider the term 'sufficient' in this context.

While companies might use external assistance to a lesser extent, the scores suggest that they see room for improvement and desire to increase the utilization of external help for change projects. In other words, companies are seeking more external assistance.

This observation aligns with the project's experiences in interacting with companies, indicating a gap and potential for external support in enhancing implementation capability.

Companies recognize that external assistance can provide valuable expertise and guidance in driving improvement projects, thus supporting their endeavors to bolster their implementation capabilities.

7 Conclusion

> ***Moreover, the project has updated the list of vulnerabilities and capabilities that are pertinent to the Danish manufacturing context in 2023.***

This report presents the findings and outcomes of a two-year project conducted at the Department of Entrepreneurship and Relationship Management, University of Southern Denmark. The project's primary focus was to enhance the resilience of Danish manufacturing companies facing supply chain disruptions, with a particular emphasis on small and medium-sized enterprises (SMEs), although the results and tools developed can also be beneficial for large companies.

In the introduction, a set of overarching questions were listed, which the project aimed to answer:

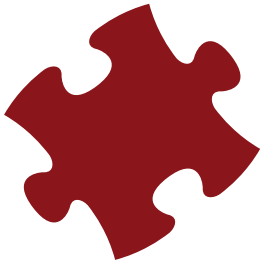
1. How can greater resilience be created in SME supply chains?
2. How should the focus on Supply Chain Resilience be organized?
3. What are the drivers and barriers for developing greater Supply Chain Resilience?
4. What vulnerabilities do Danish manufacturing SMEs experience in their supply chains?
5. What capabilities are necessary for Danish manufacturing SMEs to manage these vulnerabilities?
6. What tools are relevant for companies to strengthen Supply Chain Resilience?
7. How resilient are the supply chains of Danish manufacturing companies?

Therefore, it is pertinent to evaluate whether the project has provided valuable answers to these questions. In the following section, we will endeavor to address this based on the project's findings.

The project has introduced two significant innovations:

1. The development of a process model that emphasizes the importance of cross-functional participation throughout the process.
2. The creation of an intuitive digital tool, which employees of companies can freely download from the project's website. This tool offers concise explanations of the process through short videos.

In addition to the process model, the project has produced a comprehensive toolbox containing 32 tools. These tools are not solely limited to developing Supply Chain Resilience but can also be utilized in day-to-day operations. The toolbox includes tools for Supply Chain Management tasks, such as customer and supplier segmentation, and defining key performance indicators. Furthermore, it contains tools to enhance internal collaboration within the company,



such as conducting effective meetings and promoting active listening. The development of the toolbox has been driven by the specific needs and desires of the participating companies.

Moreover, the project has updated the list of vulnerabilities and capabilities that are pertinent to the Danish manufacturing context in 2023. These vulnerabilities and capabilities have been identified based on the valuable input from the participating companies.

We believe that greater resilience in Danish SMEs can be achieved through a structured process model, coupled with tools to drive and manage the process towards enhanced resilience. The focus should be organized using the developed approach, with cross-organizational participation from sales, production, procurement, finance, IT, and product development. With this, we consider questions 1 and 2 addressed.

Regarding question 3, frequently discussed drivers for supply chain resilience in the literature include flexibility, collaboration, surplus capacity, visibility, robustness, agility, resource restructuring, and adaptation. Significant barriers to creating supply chain resilience are a lack of information, complexity, inflexibility, inadequate capacity, and a lack of collaboration.

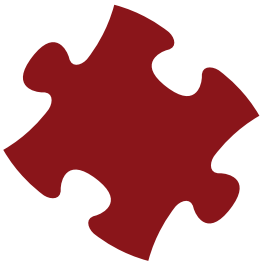
The lists of vulnerabilities and capabilities are developed based on the literature and in close collaboration with the companies – adjusted and tailored to the Danish production context. Consequently, it is presumed that these vulnerabilities and capabilities are at least applicable to the participating companies. However, we cannot make definitive statements about potential vulnerabilities and capabilities that other companies may identify. Nonetheless, we consider questions 4 and 5 satisfactorily addressed.

The project featured the involvement of 18 companies, divided into two phases: 1) a development phase and 2) a testing phase. The intention was to have 10 companies in each phase; however, two companies had to withdraw from the development phase due to the substantial workload caused by COVID-19.

During the development phase, the eight companies were visited three times. All work in this phase was carried out manually, from employees prioritizing vulnerabilities and capabilities using physical cards, to data processing (in Excel) and subsequent manual input. A valuable lesson learned during this phase was that working with predefined vulnerabilities and capabilities yielded positive results.

Nevertheless, it was evident that a more efficient data processing approach was required. Consequently, a digital solution was developed to handle vulnerabilities and capabilities, providing a quick overview of individual participants' responses and consolidating answers.

In the testing phase, 10 companies participated. The developed process model comprises four phases: 1) mapping the supply chain, 2) identifying vulnerabilities and capabilities, 3) prioritizing and fostering cross-functional alignment, and 4) developing action plans. Commencing the process with a shared mapping of the company's supply chains, including team discussions about the challenges faced, proved to be highly beneficial. Additionally,



The process model, with its predefined vulnerabilities and capabilities, offers structure and a shared terminology that participants have found highly useful.

assessing vulnerabilities and capabilities in phase 2, based on the supply chain mapping, likewise proved valuable Emphasizing individual work on vulnerabilities and capabilities ensured that all team members' opinions were considered during the joint process. The visibility of all participants' responses to the entire team often resulted in constructive dialogues, leading to the inclusion of vulnerabilities and capabilities that might have otherwise been overlooked. To assist participants in understanding the process model and its implementation, videos were provided.

The process model, with its predefined vulnerabilities and capabilities, offers structure and a shared terminology that participants have found highly useful. The structured process and toolbox were developed, tested, and refined in close collaboration with the participating companies. We believe that the developed toolbox is comprehensive and addresses question 6 concerning relevant tools.

Questionnaire Survey

As part of the project, a nationwide survey was conducted with the participation of 246 companies. The competitive situation is notably influenced by rising inflation and energy prices, scoring an average of 3.26 and 3.20, respectively, on a five-point Likert scale. Additionally, there is a reported shortage of qualified labor, particularly in the fields of engineering, industrial technicians, skilled workers, sheet metal workers, and blue-collar workers, with an average of 2.88.

One of the initial questions (Question 7) addressed the resilience of Danish supply chains. According to the survey respondents, there is a general understanding of the vulnerabilities of their companies, with an average score of 3.83 on the Likert scale. However, their understanding of the necessary capabilities to enhance resilience is slightly lower, with an average score of 3.56. When specific questions about Supply Chain Resilience measures were asked, the results indicated room for improvement. Companies scored on average between 3.19 on the ability to elevate the supply chain to a new and improved level and 3.57 on the ability to swiftly restore the supply chain to its pre-disruption state. Based on these findings, Question 7 can be answered by stating that Danish companies demonstrate some level of resilience, but there is potential for improvement.

Conversely, companies generally reported a moderate understanding of cybersecurity, with an average score of 3.49. Notably, large companies scored higher in cybersecurity knowledge, with an average of 3.88. Specifically, when it comes to preventive activities related to cybersecurity, SMEs showed room for improvement, particularly in terms of employee training in cybersecurity (average of 3.16) and collaboration with supply chain partners on cybersecurity (average of 3.16). The data also revealed that large companies have well-established guidelines for responding to cyber-attacks, effectively isolating

> ***On the whole, respondents reported strong internal integration within their companies, which serves as a positive foundation for enhancing Supply Chain Resilience.***

incidents (average of 4.20), ensuring real-time monitoring (average of 4.16), and communicating with relevant supply chain partners (average of 3.65). In comparison, SMEs obtained lower average scores, particularly in communication with supply chain partners (average of 3.14). Although there is good control over data backup and system restoration, there is a need for improvement in collaboration with supply chain partners after a cyber-attack. Overall, there is a significant knowledge gap among SMEs concerning cybersecurity, which

has implications for Supply Chain Resilience. Therefore, Question 7 must be answered by stating that Danish companies show some resilience, but there is a noticeable difference between large companies and SMEs, likely influenced by resource constraints in SMEs.

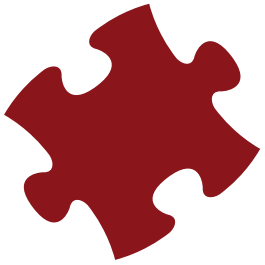
On the whole, respondents reported strong internal integration within their companies, which serves as a positive foundation for enhancing Supply Chain Resilience. However, the survey indicates a low level of digital transactions with supply chain partners. The use of software for internal processes is most prevalent in billing and payment processes (average of 4.20), processing of purchase orders (average of 3.87), and procurement management (average of 3.75). However, there is a clear potential for improvement in using software for demand management (average of 3.04) and supplier selection processes (average of 2.19).

Lastly, the survey revealed a general underutilization of external facilitators/consultants to drive and implement improvement projects (averages ranging from 2.32 to 2.54 on the five-point Likert scale). Respondents also pointed out a lack of implementation capabilities in supply chain change projects, scoring an average of 2.59.

This highlights the need for external assistance in creating more robust supply chains and presents a direct challenge to self-implementation when capabilities are lacking. Particularly among SMEs, this lack of implementation capability is considered a barrier to achieving greater resilience in Danish manufacturing companies.

In summary, the project's observations can be summarized as follows:

- Establishing common ground and a shared understanding is crucial.
- Allocating the necessary time and creating space for a common focus, even amidst a busy everyday context, is essential.
- Individual work on vulnerabilities and capabilities before addressing them collectively has proven to be valuable.
- The structured process has shown significant value in guiding the efforts.
- Visualizing vulnerabilities and engaging in open discussions about them are important steps.
- Engaging in cross-functional discussions about the necessary capabilities, including assessing current capabilities and initiating their development, is vital.
- Focusing on areas of action and concrete execution is key to progress.
- Consideration should be given to involving an external party to facilitate the process.
- Recognize that companies operate in dynamic environments, necessitating repeated efforts at reasonable intervals.




westrup
westrup

Westrup ApS

(Data collected during the autumn of 2022)

Westrup was founded in 1958 by the brothers Knud and Troels Westrup as a manufacturer of seed and grain sorting equipment. Located in Slagelse, Westrup has earned a reputation as one of the leading producers of reliable, high-quality machinery for seed treatment and grain cleaning. The company's ongoing ambition is to invent, develop, and build machines. Westrup employs 130 staff members, comprising 60 white-collar employees and 70 hourly wage workers.

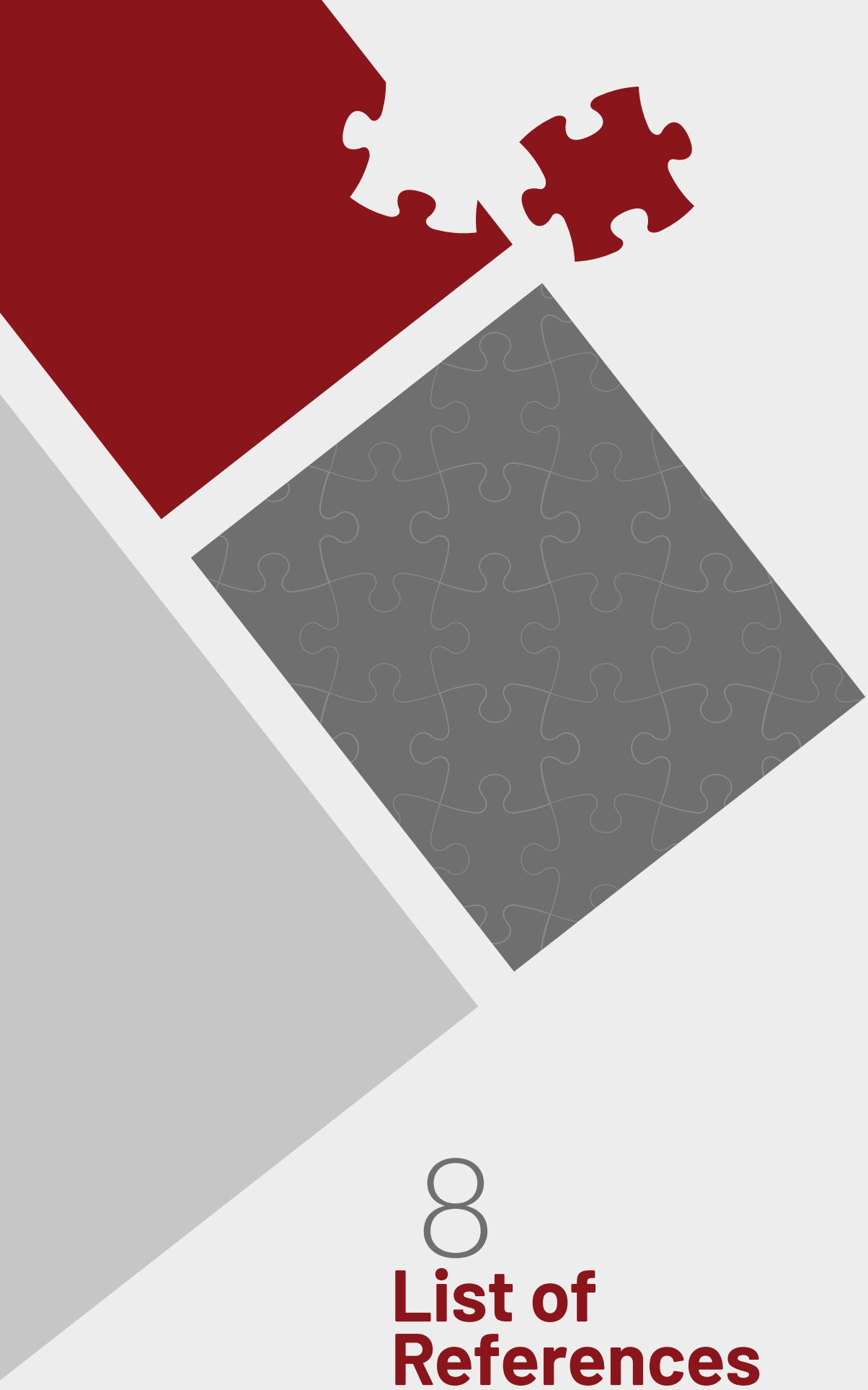
Beyond machinery, Westrup also offers knowledge and productivity-enhancing solutions to the seed and grain industry, backed by their profound understanding of the industry's development and technical advantages.

During the data collection period, Westrup encountered challenges related to establishing robustness and had short-term planning. Throughout the project, Westrup focused on addressing several vulnerabilities, including equipment reliability, low production capacity, lack of raw material availability, and a shortage of human resources.

To tackle these issues, they implemented various initiatives, such as enhancing equipment utilization, establishing contact with job centers, producing semi-finished products for inventory, developing improved forecasting methods, and exploring alternative suppliers.

For Westrup, participation in SDU's project on Supply Chain Resilience has been an eye-opener, helping us structure our approach to addressing the problems that global supply chains increasingly present. It is particularly impressive that such a complex subject is addressed in a practical manner, ensuring input and involvement throughout the company. Westrup's participation in the project has propelled us years ahead in our thinking and actions to tackle the constant challenges we face in global supply chains.

- Bo Borne Jørgensen, CEO, Westrup ApS



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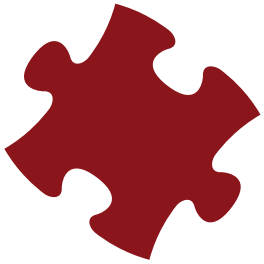

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